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PREDICTED FISSION PRODUCT RELEASE FROM OVERHEATED FUEL IN 850 MWe CANDU REACTORS: A GENERIC STUDY

by

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ABSTRACT

A generic study was carried out on the predicted fission product release from overheated fuel in CANDU 850 MWe reactors. The sensitivity of release predictions to increased fuel temperatures and to a change in the release model used in the prediction was studied.

Two fuel temperature scenarios were used, with fuel temperatures calculated by the code CHAN-II (MOD4). Based on a limited number of computer runs of the codes CURIES-II and FASTGRASS, a methodology was developed that estimates core-wide release of fission products. The representative species used in the calculations was iodine-131. A standardised form of temperature transient was used and the release was assumed to consist of four components: those due to the free inventory, due to the Zircaloy-UO_2 interaction, during the period of increasing fuel temperature and during the period of constant or nearly constant high fuel temperature.

The results show that CURIES-II predicts greater release of I-131 than does FASTGRASS under both fuel temperature scenarios. Detailed results show the variations in release from the various channel power groups and from the four fuel rings in the bundles. The increase in amount of hydrogen produced and in the heat load rejected to the moderator at the higher fuel temperatures is also documented.

RÉSUMÉ

Le présent rapport fait état des résultats d'une étude générale sur le rejet prévu de produits de fission provenant du combustible surchauffé dans les réacteurs CANDU de 850 MW(e). L'étude portait plus précisément sur la sensibilité des prévisions de rejets à l'accroissement de température du combustible et à une modification du modèle de rejet utilisé pour la prévision.

On a fait appel à deux scénarios de température de combustible en calculant la température du combustible selon le code CHAN-II(MOD4). D'après un nombre limité de passages en machine des codes CURIES-II et FASTGRASS, on a mis au point une méthode qui évalue le rejet des produits de fission à l'étendue du coeur. On a utilisé de l'iode 131 comme spécimen représentatif pour les calculs. On s'est servi d'une forme normalisée de transitoire de température et on a supposé que le rejet comprenait quatre composants: ceux dus au stock libre, ceux dus à l'interaction du Zircaloy et de l'UO_2, au cours de la période où la température du combustible augmente et au cours de la période de haute temperature constante ou presque constante du combustible.

Les résultats montrent que, pour les deux mêmes scénarios de température, le code CURIES-II prévoit des rejets plus importants d'iode 131 que le code FASTGRASS. Le détail des résultats indique des variations dans les rejets à partir des différents groupes de puissance de canal et des quatre anneaux de combustibles dans les grappes. Le rapport documente également l'augmentation de l'hydrogène produit et de la charge thermique rejetée dans le modérateur.

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A. INTRODUCTION

During a postulated reactor accident, many factors need to be taken into account in coming to a determination of the temperatures that could be experienced by the fuel. Some of these factors, by way of example, are the behaviour of fuel bundles and other channel components during the transient, the magnitude of steam flows through the channel and the paths taken by the steam in flowing around and through the fuel bundles, and the timing and extent of the reaction that might occur between the steam and channel components. Some uncertainty attaches to predictions of fuel temperatures under accident conditions, due to inevitable gaps in our knowledge and less than perfect predictive tools.

Since the fuel temperatures during an accident can be expected to have a direct impact on predictions of fission product release, uncertainties in the value of the former quantity will lead to uncertainties in the latter. The present report describes work that was undertaken to provide an understanding of the effect of different fuel temperatures and release models on predicted fission product releases. The work was generic in nature and applies directly to CANDU reactors of the 850 MWe design. Some application may be made to other CANDU designs although direct comparisons probably cannot be made. In the following sections, the overall assessment methodology will be presented, the means by which fuel temperatures were obtained will be discussed and the release models and how they were used will be described.

B. ASSESSMENT METHODOLOGY

1. General

The work performed for the present project can be described generally under four main headings. The two major pieces of work were associated with:

(1) information collection and discussions at Argonne National Laboratory on fuel and fission product behaviour, materials properties and hydrogen evolution;

(2) study and report on the effects on fission product release of changes in fuel temperature and of different fission product release models.

The two further topics, which are related to item (2), are:

(3) estimate the increase in hydrogen source term to containment as a result of higher fuel temperatures;

(4) estimate the increased heat load to the moderator as a result of higher fuel temperatures.

Documentation of the first topic is covered by a trip report[1] prepared and submitted separately from this report. The work and results of the other three topics are covered in what follows.

Estimating the fission product release from an entire CANDU core is not a trivial problem due, in part, to the number of fuel elements present and the range of transients that they might undergo. As an example, in one fuel channel of an 850 MWe reactor, there are 481 fuel elements. There are at least 28 different power histories represented among these elements and up to 91 or more distinct temperature transients might be experienced by this assembly of elements during a transient. To perform a release calculation for each element would be excessively expensive and time consuming. Furthermore, the calculation would need to be repeated if a change in boundary conditions resulted in a significant change in the nature of the transient overall.

2. Outline of the Approach

To overcome these difficulties, a flexible and relatively straightforward method for estimating releases from the core was developed as part of this project.

In brief, the approach used was as follows.

(1) Release from the fuel was assumed to comprise up to four components: release of the free inventory; release during the temperature ramp; release during the hold period; release due to the Zr-UO_2 interaction.

(2) Procedures for determining the free inventory and the amount of fission product released by the Zr-UO_2 interaction were chosen and were applied equally to all the cases studied.

(3) The transients experienced by the elements in the rings of each bundle in five channel power groups were represented in a standard format. This format consisted of a ramp at constant ramp rate to some temperature followed by a hold period at that temperature.

Any temperature transient in the core can be represented, therefore, by a curve such as Figure 1. A particular transient is characterized by some set of the time and temperature variables shown in the Figure.

(4) Three transients having this standard format were chosen such that their ramp rates and hold times spanned all the expected conditions in the core. Release fractions corresponding to regular time intervals throughout these transients were obtained for each of the release models used, giving two matrices of release fractions for each model: one for the ramp period and one for the hold period.

(5) These matrices of release fractions were then applied to the temperature transients seen by the fuel (point (3)), interpolating within the matrices to find the appropriate ramp rate fraction or hold fraction.

(6) All the releases were then summed to give channel and half core releases.

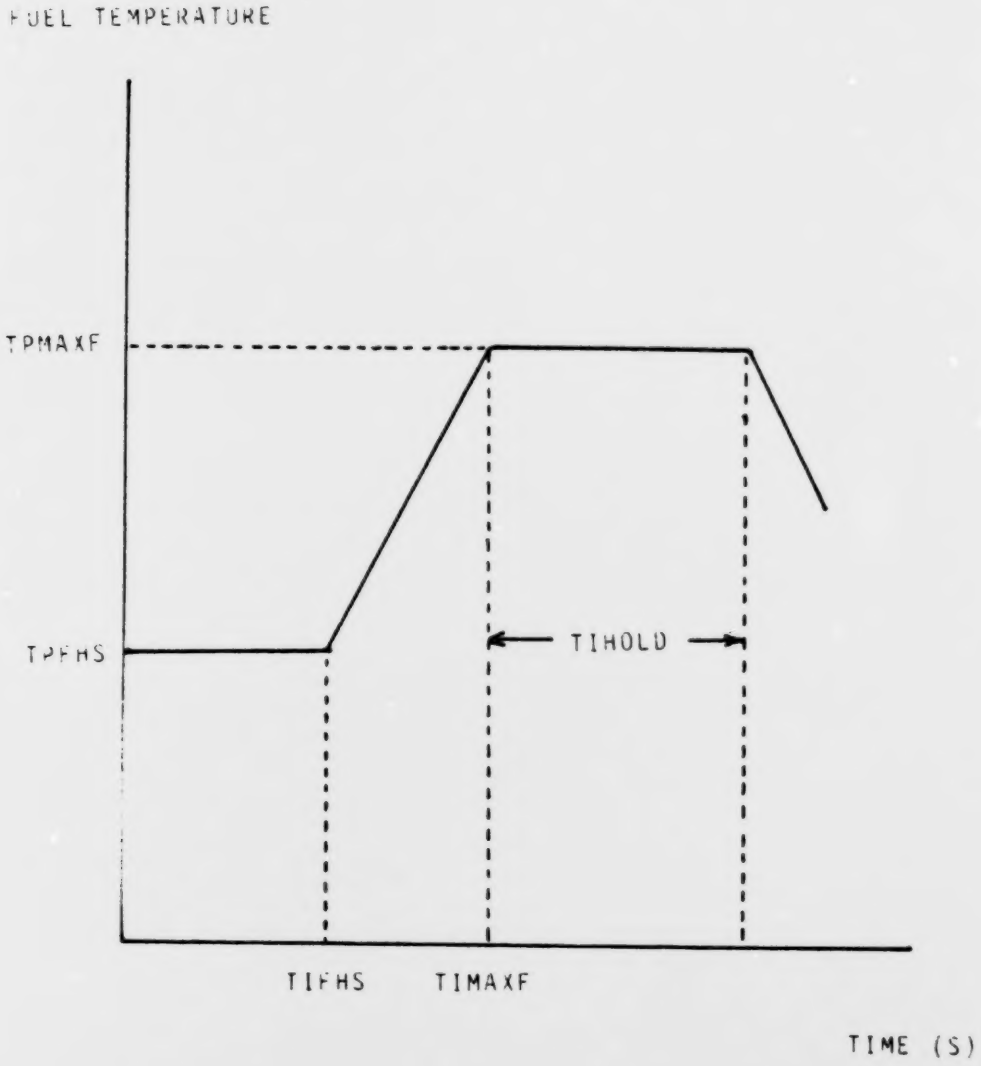

FIGURE 1. STANDARDIZED TEMPERATURE TRANSIENT.

3. Overview of Specific Method Used

The above approach was translated into a specific method for calculating releases from the fuel. This method is embodied in the REST (short for Release ESTimate) code; all calculations and data handling that are required to determine the total release from the UO_2 are carried out by REST. The steps in this operation and the nature of the data manipulations performed by REST will now be described briefly.

To determine the total release from a fuel element, the four components of release (i.e. free inventory, release during the temperature ramp, release during the constant temperature period, release due to the Zr-UO_2 interaction) have to be calculated. Each of these components was calculated as follows.

3.1 Free Inventory

To calculate the I-131 inventory in the fuel-to-sheath gap of an element, we need the total I-131 inventory in the element and the fraction of this total that is released to the gap in steady state operation.

The steps involved here are:

(i) determine the element power for single elements in each ring of each bundle in the channel. This is calculated in REST using bundle powers (which are input data) and the fractional ring powers and numbers of elements in each ring (both pieces of data hard-wired into REST).

(ii) for each element, calculate the total I-131 inventory. This number is calculated in REST using the element power from the previous step and an equilibrium activity coefficient of 27 Ci I-131 per kW (hard-wired into REST). These two steps are carried out for each ring of each bundle in the channel, giving the total I-131 inventory of each element in the channel.

(iii) determine the fraction of this total that is released from the UO_2 and is present in the element as the free inventory. Starting with the element powers from step (i), this fraction is found in REST by linear interpolation in a table of free inventory fractions versus element power. The table is a DATA statement and the fractions in it were obtained from predictions of the Ontario Hydro fission product distribution model (Muzumdar). The inventory remaining in the UO_2 is the difference between the total inventory and the free inventory. This value is calculated in REST and stored in an array.

(iv) calculate free inventory in each element by multiplying the total inventory from step (ii) by the fraction from step (iii). This calculation is carried out in REST and the result stored in an array.

3.2 Release During the Temperature Ramp

The release of I-131 from the UO_2 during the period of temperature increase will depend on the peak temperature reached and on the rate of temperature increase.

The steps involved in this calculation are:

(i) determine the rate of temperature increase from the initial and final temperatures and the corresponding times. These values are input data to REST and form part of the time and temperature data shown in Appendix B. The calculation of ramp rate is carried out in REST for each ring of each bundle in the channel.

(ii) determine the fractional release from the UO_2 at the peak temperature by linear interpolation in a table of fractional releases as a function of temperature. There are two such tables, one for CURIES-II and one for FASTGRASS. They are both structured the same: fractional releases are given at 50° intervals from 1100° C to fuel melting for each of three ramp rates, 1, 5 and 10 K/s. The fractional release numbers in these tables were obtained from CURIES-II and FASTGRASS results.

The interpolation carried out by REST in these tables is therefore a double linear interpolation. The code interpolates on ramp rate and on temperature to obtain the final fractional release from the UO_2 for each element in the channel.

(iii) for each element, calculate the release from the UO_2 using the I-131 inventory in the UO_2 determined in the free inventory calculation and the fractional release during the temperature ramp from (ii) above. This calculation is performed in REST and the results stored in an array.

3.3 Release During the Constant Temperature Period

To approximate the release of fission products from the UO_2 during periods of constant temperature, separate approaches were used for CURIES-II and FASTGRASS.

It was found that the constant temperature release predicted by CURIES-II could be approximated using a set of temperature dependent rate constants, k, such that

$$f = (1.0 - e^{-kt}) \qquad (1)$$

where f is the fractional release from the UO_2, k is a constant dependent on temperature and t is time.

For CURIES-II, the steps needed to estimate the release during constant temperature periods are:

(i) determine the rate constants, k, for a set of temperatures from 1000° C at 100° intervals to fuel melting. This was done outside REST (see Appendix A) and the rate constants so obtained were inserted into REST in a DATA statement.

(ii) calculate the rate constant for the peak temperature seen by a particular element by linear interpolation in the set of rate constants in (i). This interpolation is done in REST.

(iii) calculate the fractional release from the UO_2 using the rate constant from (ii) and an equation of the form of (1). This calculation is done in REST.

(iv) calculate the release from each element in the channel during the hold period using the I-131 inventories in the UO_2 that were determined in the free inventory calculation and the fractional release numbers from (iii) above. The results are stored in an array.

For FASTGRASS, the release from the UO_2 during constant temperature periods was found to be approximated by equation (2). This equation was fitted to a curve plotted from FASTGRASS results. The equation appears again in section C.4 and is also identified there as equation (2).

$$f = 5.031 \times 10^{-14} \, e^{(0.009423 \times T)} \qquad (2)$$

In this equation, f is the fraction of the initial inventory in the UO_2 that is released per second during the hold period and T is the absolute temperature. This equation was coded directly

into REST and the release during the hold period could be calculated using this coded equation, the time of the temperature hold and the I-131 inventory in the UO_2 that was determined in the free inventory calculation. The result is stored in an array.

3.4 Release Due to the Zr-UO_2 Interaction

For any element whose temperature exceeded 1850° C, 10% of the I-131 inventory in the UO_2 was assumed to be released due to the Zr-UO_2 interaction. This calculation is performed for each element in REST.

3.5 Summing the Components

The releases from the UO_2 due to the above four components are then summed in REST for all elements in each ring. Since it is possible by this method to calculate a release greater than the total inventory remaining in the UO_2, a check is made in REST of the fractional release predicted. If this fraction is greater than 1.0 the code reduces the fraction to 1.0.

4. Details of the Calculation

4.1 Variables Considered

The steady state and transient variables that were considered in the work were, respectively,

. element power and burnup,

and,

. fuel temperatures at the start of the transient, temperature ramp rate, peak temperature reached and the time that the fuel remained at the peak temperature.

4.2 Assumptions Implicit in Standard Transients

A number of assumptions are implicit in the use of the standard format transients to approximate the transients predicted by CHAN. These assumptions are:

(1) for any element, the ramp rate is constant from the beginning of the transient to the time at which the peak temperature is reached;

(2) that portion of the transient near the peak temperature can be approximated by a constant temperature hold period at or near the peak temperature;

(3) releases during the declining portion of the temperature transient can be neglected.

4.3 Free Inventory Calculation

Calculation of the free inventory of an element relies on the free inventory calculated in CURIES-II for fuel in the 850 MWe reactor type. A matrix of releases from the UO_2 to the free inventory as a function of element linear power is constructed. The actual steady state element powers in a channel are calculated starting from the bundle powers. Specific free inventories for particular elements can then be determined by interpolating in the free inventory matrix.

4.4 Criterion for Releases Due to Zr-UO_2 Interaction

Releases due to the Zircaloy-UO_2 interaction were obtained by assuming that for any element whose fuel temperature exceeds the sheath melting temperature, 10% of the total inventory is released.

4.5 Ramp and Hold Releases

The matrices of release fractions for the ramp and hold periods, and their application, can be illustrated using CURIES-II as an example. Runs were performed with this code at ramp rates of 1, 5 and 10 K/s to peak temperatures of 2000, 2500 and 3000 K. The runs were started at some low temperature, typically 1000 K, the temperature was ramped to the desired final point then held at that peak temperature. From these runs, releases during the ramp for all three ramp rates and at temperature intervals of 50 K were selected and a matrix constructed with these release values. It was found that releases during the hold period could be approximated using a rate constant method dependent on temperature and time. A second matrix was constructed consisting of these rate constants at 100 K intervals.

A similar, although not identical, procedure was followed with FASTGRASS.

4.6 Overall Releases

The releases from these four separate components are then summed to give a total release for the particular element and transient. The calculations described here are carried out for each ring of all bundles in a channel by REST.

4.7 Cases Run

The customary five channel powers were used and for each of these, two temperature transients were calculated: a reference case and a high temperature case. Two release models were used in the work: CURIES-II and FASTGRASS. Thus there were four estimates of releases from the core calculated. The species used in the work was iodine-131.

4.8 Validation of REST

Once the CURIES-II runs were completed and the CURIES version of REST was debugged and operating, the validity of the approach was checked by reproducing the predictions of CURIES-II for a 7.5 MW channel at the reference temperature. The results of this check are shown in Tables 1 and 2. The agreement between the two predictions is seen to be good. The range of fuel temperatures found in the 7.5 MW channel for this case was thought to be wide enough that the method could be considered validated for purposes of the project, and that its use with other temperature transients would not result in large errors.

TABLE 1. REST AND CURIES-II PREDICTIONS OF ADDITIONAL DIFFUSIONAL RELEASE (Ci I-131) FROM A 7.5 MW CHANNEL, REFERENCE TEMPERATURE CASE

BUNDLE	1	2	3	4	5	6	7
CURIES-II (350 S)	0.0	0.0	0.3	22	111	189	412
CURIES-II (1000 S)	0.0	0.0	0.3	25	112	191	414
REST (350 S)	0.0	0.0	0.0	25	147	204	665

BUNDLE	8	9	10	11	12	13
CURIES-II (350 S)	642	206	133	75	0.1	0.0
CURIES-II (1000 S)	645	209	135	77	0.1	0.0
REST (350 S)	737	200	152	98	0.0	0.0

TOTAL DIFFUSIONAL RELEASE (Ci) :

CURIES-II (350 S)	1808
REST (350 S)	2228

TABLE 2. OVERALL REST AND CURIES-II RELEASE (Ci I-131) PREDICTIONS FOR A 7.5 MW CHANNEL, REFERENCE TEMPERATURE CASE

MODEL	TIME (S)	COMPONENT	RELEASE (Ci)
CURIES-II	350		7251
CURIES-II	1000		8372
REST	350	DIFFUSIONAL	2228
		FREE INVENTORY	3266
		ZR-UO_2	2291
		TOTAL :	7785

C. DESCRIPTION OF WORK PERFORMED

In this section, specific information is given on the computer codes that were used in the work, the nature of the results obtained from these codes and the way in which these results were used. A significant part of the project involved determining the modifications, if any, that had to be made to the codes, the number of runs required and the input data needed. The code modifications that were made are described in Appendix A. Brief descriptions of code structure or operation are included in this section where appropriate.

1. Computer Codes Used

Four computer codes were used in the course of this work. They are CHAN-II (MOD4), CURIES-II, FASTGRASS, AND REST. The first two of these were obtained from Ontario Hydro; the third was obtained from J. Rest of Argonne National Laboratory and the fourth was written by Idea Research as part of the project.

CHAN-II (MOD4) was used to produce all the temperature transients that were used either directly or indirectly in the work. A fuller description of the use made of CHAN, and the temperature predictions provided by it, is given in section C.2 below.

CURIES-II and FASTGRASS provided the two sets of release predictions used in the work. Their use is described below in sections C.3 and C.4.

REST was written to bring together the temperature transients and the matrices of results produced by CURIES-II and FASTGRASS and calculate releases from all bundles in one channel, as indicated in section B (Assessment Methodology) above. Two versions of REST were developed: one for runs using release data calculated by CURIES-II and one for FASTGRASS data. A very brief description of the structure and operation of REST appears in section C.5 below.

2. CHAN Fuel Temperature Transients

CHAN-II (MOD 4) calculates the temperatures and certain physical conditions of all channel components during a transient, given the power levels and temperatures at which the fuel elements are operating in steady state, the steam flow and cooling conditions that apply during the transient and the values of a number of criteria relating to channel behaviour or the properties of channel components. CHAN also calculates the amount of hydrogen produced during a transient due to the reaction between steam and Zircaloy, and the amount of heat transferred to the moderator. A full discussion of the operation and capabilities of CHAN is given in references 2 and 3.

In the CHAN analysis for 850 MWe type reactors, the channels in the core are normally grouped under five specific channel powers, as shown in Table 3. This table also shows the bundle powers that are used for each of the channel powers. These channel and bundle power data were used in the present work.

Two sets of temperature transients were calculated for this project. The first, or reference temperature calculations, were the same, with one exception, as those used in the base case submissions for the 850 MWe reactors, i.e. steam flows of 100 g/s in the channels during the transient, 95%/5% flow splits, and all channel component properties and behaviour criteria as supplied by Ontario Hydro with the sample cases (see Appendix D). The exception was that the error, which had been identified earlier[3], in calculating the temperature of the centre pin, was corrected. A reference temperature transient calculation was carried out for each of the five channel powers.

The second set of temperature calculations (high temperature) differed from the first only in that the reaction between steam and Zircaloy in the channels was allowed to occur at temperatures above the Zircaloy melting temperature. The reaction rates used were those of Urbanic-Heidrick.

In both sets of temperature calculations, CHAN printout was obtained at 50 second intervals. A summary table of these two sets of results, showing the peak temperatures reached for each of the repesentative channels, is included as Table 4.

TABLE 3. CHANNEL AND BUNDLE POWERS USED IN THIS STUDY

CHANNEL POWER (MW)	CHANNELS WITH THIS POWER	BUNDLE POWERS (kW)
7.5	9	82.4, 315.2, 553.1, 706.5, 751.6, 828.2, 832.8, 852.0, 786.7, 758.7, 603.6, 343.5, 88.5
6.7	47	73.6, 281.5, 494.0, 631.0, 671.4, 739.8, 743.9, 761.0, 702.6, 677.7, 539.2, 306.8, 78.9
6.2	83	68.1, 260.4, 457.0, 583.8, 621.1, 684.4, 688.2, 704.0, 650.0, 626.9, 498.8, 283.8, 73.1
5.7	57	48.2, 198.2, 375.3, 529.0, 631.0, 715.5, 731.0, 714.9, 633.2, 540.4, 393.7, 139.4, 50.9
4.6	44	38.9, 160.0, 302.9, 427.0, 509.3, 577.5, 590.0, 577.0, 511.1, 436.1, 317.8, 112.5, 41.1

TABLE 4. PEAK FUEL TEMPERATURES PREDICTED BY CHAN-II (MOD4)

REFERENCE TEMPERATURE CASES

CHANNEL POWER (MW)	PEAK RING TEMPERATURES (°C) CENTRE	INNER	INTER	OUTER
7.5	2033	1975	1789	1471
6.7	1947	1880	1696	1358
6.2	1931	1882	1646	1261
5.7	1939	1889	1630	1292
4.6	1534	1451	1229	1073

HIGH TEMPERATURE CASES

CHANNEL POWER (MW)	PEAK RING TEMPERATURES (°C) CENTRE	INNER	INTER	OUTER
7.5	2467	2343	1950	1471
6.7	2364	2231	1816	1358
6.2	2282	2148	1731	1261
5.7	2255	2123	1707	1292
4.6	1534	1451	1229	1073

Based on the CHAN output, values for the five variables shown on Figure 1 were defined. All temperatures used are fuel temperatures. In all cases the stylized transient was assumed to start at time zero. The length of the hold period was the time during which the fuel temperature remained near (i.e. within approximately 20-30°) the predicted peak temperature; values for the other variables were taken directly from the CHAN output. As a simplifying assumption, no account was taken of the contact zone. This assumption was made to keep the coding in REST and the input to REST as simple as possible. Taking account of the lower temperatures in the contact zone would have resulted in somewhat lower release predictions for all the cases but would not have affected the main conclusions. Therefore, the input data to REST gives only one peak temperature per ring. This temperature is the fuel temperature in the non-contact region.

The times and temperatures that were drawn from the CHAN runs in this way are presented in Appendix B as Tables B.1 to B.130. Fuel temperatures in the contact zones are shown in these tables for completeness but, as indicated above, they are not used as input to REST.

3. CURIES-II Fission Product Release Calculations

CURIES-II[4] runs were performed for element powers ranging from 10 to 70 kW/m, 200 day dwell period and for transients of 1, 5 and 10 K/s ramp rates to 2000, 2500 and 3000 K. In each transient run, following the ramp there was a period during which the temperature was held at the value reached at the end of the ramp. Printout during the transient was obtained every 50 seconds throughout both the ramp and hold periods. These runs provided the data for the free inventory matrix and the matrix of releases during the ramp, which are reproduced here as Tables 5 and 6. Releases during the hold period were calculated in REST using the rate constants given in Table 7. The calculations used to produce these rate constants are given in Appendix A.

CURIES-II runs were also performed using data produced by CHAN (reference temperatures) and read from tape by CURIES. These runs were therefore a repeat of the base case fission product release predictions for the 850 MWe reactor type. They were used to check that the CURIES version of REST was reproducing the base case reasonably well.

TABLE 5. CURIES-II STEADY STATE I-131 DISTRIBUTION

ELEMENT LINEAR POWER (kW/m)	TOTAL INVENTORY (Ci I-131)	G.B. FRACTION	FREE FRACTION
10	129	0.0	.0001
15	193.8	.000185	.000004
20	258.4	.0008	.000005
25	322.9	.001920	.000007
30	387.6	.003452	.000085
35	452.2	.005223	.000385
40	516.7	.008545	.001764
45	581.4	.016655	.010547
50	645.9	.028791	.034754
55	710.5	.040181	.071285
60	775.1	.046636	.113513
65	839.7	.049883	.157258
70	904.3	.048949	.203651

TABLE 6. I-131 RELEASE FRACTIONS DURING RAMP AT CONSTANT RAMP RATE (AS PREDICTED BY CURIES-II)

TEMPERATURE (°C)	RELEASE FRACTION 1 K/S	5 K/S	10 K/S
1100	.00006	.00006	.00006
1150	.00010	.00008	.00008
1200	.00015	.00012	.00012
1250	.00023	.00017	.00017
1300	.00032	.00022	.00022
1350	.00046	.00031	.00030
1400	.00063	.00042	.00040
1450	.00086	.00056	.00054
1500	.00115	.00074	.00072
1550	.00152	.00097	.00094
1600	.00197	.00126	.00121
1650	.00252	.00160	.00153
1700	.00319	.00202	.00193
1750	.00399	.00252	.00241
1800	.00495	.00348	.00337
1850	.00747	.00601	.00590
1900	.01714	.01570	.01559
1950	.04405	.04268	.04257
2000	.11134	.11013	.11004
2050	.27142	.27061	.27053
2100	.63772	.63772	.63772
2150	.91538	.91538	.91538
2200	.99646	.99646	.99646
2250	1.0	1.0	1.0
2300	1.0	1.0	1.0
2350	1.0	1.0	1.0
2400	1.0	1.0	1.0
2450	1.0	1.0	1.0
2500	1.0	1.0	1.0
2550	1.0	1.0	1.0
2600	1.0	1.0	1.0
2650	1.0	1.0	1.0
2700	1.0	1.0	1.0
2750	1.0	1.0	1.0
2800	1.0	1.0	1.0
2850	1.0	1.0	1.0

TABLE 7. RATE CONSTANTS FOR RELEASE OF I-131 DURING CONSTANT TEMPERATURE HOLD PERIOD (FROM CURIES-II RELEASE EQUATIONS)

TEMPERATURE (°C)	RATE CONSTANT FOR RELEASE (SEC^{-1})
1000	2.47-07
1400	5.01-06
1500	8.61-06
1600	1.39-05
1700	2.16-05
1800	3.19-05
1900	2.48-04
2000	1.85-03
2100	1.47-02
2200	8.00-02
2300	8.00-02
2400	8.00-02
2500	8.00-02
2600	8.00-02

4. FASTGRASS Fission Product Release Calculations

In using FASTGRASS[5], no attempt was made to model a complete fuel element in one file. Instead, individual runs were carried out to represent UO_2 under various sets of local conditions typical of CANDU fuel over a range of powers and steady state irradiation temperatures. For all these cases, the steady state was continued to a burnup of 0.7 atom %, corresponding to approximately 160 MWh/kgU. Each steady state was followed by a transient with a ramp rate of 1, 5 or 10 K/s to 2000, 2500 or 3000 K. In turn, a 1000 second hold followed the ramp in each transient. Printout during the transients was obtained at 50 K intervals during the ramp and at each 100 seconds during the hold period.

From the FASTGRASS results, the releases of I-131 during the ramp and the hold period are shown in Appendix C as Tables C.1 to C.28. From these data, the matrix of releases during the ramp that was incorporated into REST (FASTGRASS version) is shown in Table 8. The power level in the FASTGRASS run that was used to generate the data in Table 8 was 40 kW/m, the same power level that underlies the CURIES-II data in Table 6. For the hold period, it was found that over a considerable temperature range there was a constant fractional release during each 100 second interval of the hold period, as shown in Figure 2. An equation can be fitted to this curve giving the fractional release of the initial I-131 inventory that would be released per second during a hold period, and this equation is found to be

$$f = 5.031 \times 10^{-14} \, e^{(0.009423 \times T)} \qquad (1)$$

where f is a fractional release per second and T is the absolute temperature.

This equation was coded directly into REST (FASTGRASS version).

5. REST Fission Product Release Calculations

REST is a straightforward bookkeeping code. It performs data look-ups, linear interpolations in data tables and simple arithmetical operations such as the calculation of element powers from bundle powers, evaluation of exponents and summations. No equations are solved in REST. The code matches up fuel temperature histories (which are input) with tables of fractional release as a function of temperature. These tables are stored in the code. The components of release are calculated using these data tables and simple calculations. The results are summed to give total release from the UO_2.

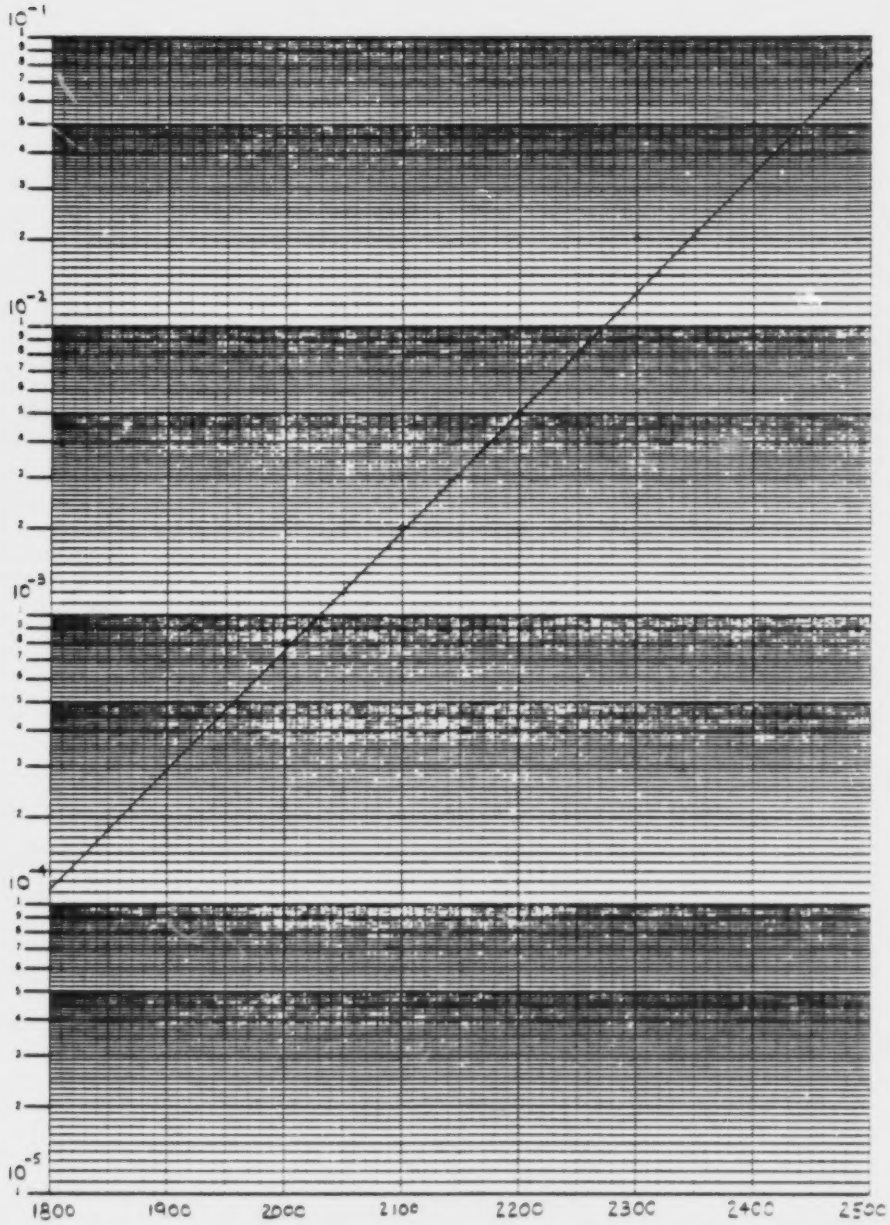

FIGURE 2. FASTGRASS RELEASE PREDICTIONS. FRACTIONAL RELEASE PER 100 SECONDS DURING TEMPERATURE HOLD.

TABLE 8. FASTGRASS FRACTIONAL RELEASES OF I-131 DURING TEMPERATURE RAMPS AT CONSTANT RAMP RATES

TEMPERATURE	FRACTIONAL RELEASE		
(°C)	1 K/S	5 K/S	10K/S
1100	4.909-06	4.909-06	4.909-06
1150	4.520-05	1.391-05	6.454-06
1200	9.296-05	4.528-05	1.636-05
1250	9.395-05	8.429-05	3.837-05
1300	9.551-05	1.182-04	6.773-05
1350	1.032-04	1.710-04	1.074-04
1400	1.116-04	2.926-04	1.824-04
1450	1.226-04	5.436-04	3.578-04
1500	1.534-04	9.910-04	6.925-04
1550	2.063-04	1.502-03	1.207-03
1600	2.965-04	1.810-03	1.775-03
1650	4.548-04	1.937-03	2.178-03
1700	7.305-04	2.019-03	2.411-03
1750	1.206-03	2.117-03	2.565-03
1800	2.026-03	2.265-03	2.699-03
1850	3.445-03	2.499-03	2.859-03
1900	5.900-03	2.875-03	3.087-03
1950	1.011-02	3.477-03	3.434-03
2000	1.716-02	4.440-03	3.964-03
2050	2.862-02	5.983-03	4.780-03
2100	4.661-02	8.455-03	6.037-03
2150	7.386-02	1.238-02	8.059-03
2200	.1137	1.855-02	1.174-02
2250	.1695	2.836-02	1.973-02
2300	.2439	4.495-02	3.893-02
2350	.3389	7.555-02	8.229-02
2400	.4444	.1325	.1593
2450	.5450	.2280	.2695
2500	.6383	.3592	.4068
2550	.7228	.4964	.5524
2600	.7948	.6189	.6784
2650	.8538	.7262	.7770
2700	.8999	.8110	.8545

As input, REST requires bundle powers, the time step to be used in the calculation, and the temperatures and times, such as those given in Appendix B, characterising the transients seen by the fuel elements. Results are printed out in two forms. The first is a set of summary tables giving the amounts of fission product available for release for each of the four release components.

One such table is presented at each time step in the transient and shows the components available for release from each ring of each bundle in the channel at that point in the transient. The second is a set of summary tables, one table per bundle, showing the total fission product available for release from each ring of the bundle at each time step in the transient.

I-131 is the only isotope considered in the calculations. The total inventory of the isotope in each ring of all the bundles is calculated within the code, as are the free inventories. These latter are based on values calculated by CURIES-II, using fractional release numbers hard-wired in a DATA statement in the code. Ramp and hold releases are calculated using the matrices described above, which are also contained in DATA statements, and using the time and temperature data that are supplied as input. The fractional release from fuel undergoing Zircaloy-UO_2 interaction is 0.1 and a check is made to ensure that a fractional release greater than 1.0 from any element, due to all mechanisms, is not possible. Execution time per run is about one second on the Multiple Access system. One run calculates the releases from all elements in one channel during the transient.

There are two separate versions of REST, one incorporating CURIES-II data and the other FASTGRASS data. The input data required for both is the same and output also has the same format. Aside from the different data tables for calculating ramp releases, and the different methods for determining hold releases, the codes are identical.

Twenty runs were performed with REST, 10 with the CURIES-II version (5 reference temperature runs and five high temperature runs) and 10 with the FASTGRASS version. The results from these runs are discussed in the next section.

D. DISCUSSION OF RESULTS

1. Overview

Starting with fuel temperatures as predicted by CHAN, the peak temperatures for the reference and high temperature cases are shown in Table 4. From this table it can be seen that for the 7.5 to 5.7 MW channels, the peak temperatures for the high temperature cases are between 300 and 400 K higher than in the reference cases. There was no change in the temperatures of the 4.6 MW channel since no Zircaloy-water reaction took place there in either case.

For the reference temperature, the potential for release of I-131 as predicted by REST (CURIES-II) was 0.497 MCi, of which 0.133 MCi or about 27% was diffusional release. For REST (FASTGRASS) the corresponding figures are 0.388 MCi and 0.026 MCi (6.8%). At the higher temperatures, a dramatic increase in releases would be expected, and this was, in fact, predicted by the code. For the high temperature case, REST (CURIES-II) predicted potential total releases of 2.93 MCi of which about 82% (2.39 MCi) could be attributed to diffusional releases during the transient. The corresponding predictions of REST (FASTGRASS) were 0.723 MCi total and 0.28 MCi (38%). For the reference transient, the diffusional releases predicted by REST (CURIES-II) were about five times greater than those predicted by REST (FASTGRASS). At the higher temperatures, the CURIES transient releases were about 18 times greater than for the reference case while with FASTGRASS the increase was a factor of about 10.

These results will be presented and considered in more detail in the following three sections.

2. Effect of Temperature on Fission Product Release

The releases from the various channel power groups for the two temperatures and models are shown in Tables 9 and 10. From these tables it will be seen that the releases from the high power 7.5 MW channel group form only a small portion of the total releases. The reason for this is the small number of these high power channels, as can be seen from Table 11.

The numbers in Tables 9 and 10 include all the components of release, including the $Zr\text{-}UO_2$ reaction release which does not change from one model to the other at the same temperature. They also include the free inventory which does not change at all in this work.

Those components that do vary are the releases that appear during the heatup and hold periods. These releases are shown in Tables 12 and 13 and the variation in the transient releases over the four channel groups from one temperature to the other can be seen. The transient releases from the 4.6 MW channels were the same for both cases since the fuel temperatures predicted by CHAN for this channel power were the same for both the "reference" and the "high" temperature cases. From Tables 12 and 13 the factors 18 and 10 that were noted in the Overview section can be determined.

Releases due to the $Zr\text{-}UO_2$ interaction are also temperature dependent. This is seen from Table 14. In this table, the reference and high temperature $Zr\text{-}UO_2$ values are from the FASTGRASS version of REST. It will be noted from the REST (CURIES-II) runs that in the high temperature case no $Zr\text{-}UO_2$ release is indicated from some bundle and ring positions where a contribution would be expected. The reason for this is that at those positions, all the bound inventory had already been released by diffusion so that none was left to be released by the alloy mechanism. These numbers result from the the way the calculation was carried out and are not intended to be a realistic description of what would happen in a real channel.

As well as the variation in releases from channel to channel, there are also noteworthy changes in release from the different fuel rings within a channel. Table 15 shows the changes in "diffusional" and $Zr\text{-}UO_2$ releases from the four rings of all bundles in a 7.5 MW channel for both models at the reference and high temperatures. Although the peak temperatures occur at the centre element, in magnitude the greatest increase in releases comes from the inner ring. For the other channel powers, the pattern of changes in releases on going to the higher temperature is qualitatively similar to that shown in Table 15.

TABLE 9. TOTAL RELEASE (Ci I-131) PER CHANNEL AND PER CHANNEL GROUP

REST (CURIES-II) RELEASES FOR REFERENCE TEMPERATURE CASE

CHANNEL POWER (MW)	RELEASE (ONE CHANNEL) (Ci I-131)	RELEASE (ALL CHANNELS) (Ci I-131)	CHANNEL GROUP RELEASE/ TOTAL (%)
7.5	8132	7.32 +04	14.7
6.7	3275	1.54 +05	31.0
6.2	2108	1.75 +05	35.2
5.7	1619	9.23 +04	18.6
4.6	52	2.29 +03	0.5

REST (FASTGRASS) RELEASES FOR REFERENCE TEMPERATURE CASE

CHANNEL POWER (MW)	RELEASE (ONE CHANNEL) (Ci I-131)	RELEASE (ALL CHANNELS) (Ci I-131)	CHANNEL GROUP RELEASE/ TOTAL (%)
7.5	5942	5.35 +04	13.8
6.7	2710	1.27 +05	32.7
6.2	1622	1.35 +05	34.8
5.7	1251	7.13 +04	18.4
4.6	29	1.28 +03	0.3

TABLE 10. TOTAL RELEASE (Ci I-131) PER CHANNEL AND PER CHANNEL GROUP

REST (CURIES-II) RELEASES FOR HIGH TEMPERATURE CASE

CHANNEL POWER (MW)	RELEASE (ONE CHANNEL) (Ci I-131)	RELEASE (ALL CHANNELS) (Ci I-131)	CHANNEL GROUP RELEASE/ TOTAL (%)
7.5	29524	2.66 +05	9.1
6.7	17335	8.15 +05	27.9
6.2	13357	1.11 +06	37.9
5.7	12859	7.33 +05	25.1
4.6	52	2.23 +03	0.1

REST (FASTGRASS) RELEASES FOR HIGH TEMPERATURE CASE

CHANNEL POWER (MW)	RELEASE (ONE CHANNEL) (Ci I-131)	RELEASE (ALL CHANNELS) (Ci I-131)	CHANNEL GROUP RELEASE/ TOTAL (%)
7.5	15163	1.37 +05	18.8
6.7	4827	2.27 +05	31.1
6.2	2775	2.30 +05	31.5
5.7	2359	1.35 +05	18.5
4.6	29	1.28 +03	0.2

TABLE 11. FRACTION OF CORE POWER CONTRIBUTED BY CHANNEL POWER GROUPS

CHANNEL POWER (MW)	TOTAL POWER THIS GROUP (MW)	% HALF CORE POWER
7.5	67.5	4.7
6.7	314.9	22.1
6.2	514.6	36.1
5.7	324.9	22.8
4.6	202.4	14.2

3. Effect of Release Model on Fission Product Release

On the basis of this work, the differences between the two models can be pointed out in a variety of ways. Four comparisons of the results will be made here:

. effect on overall ramp and hold releases;

. effect on ramp and hold releases from the five channel groups;

. comparison of predicted release fractions at temperature intervals during ramps at constant ramp rates;

. comparison of release rates during constant temperature hold periods.

At a deeper level, the results could be explained in terms of the detailed mechanisms in FASTGRASS and CURIES-II and the operation and relative importance of these models over the temperature range studied. Interpretation at this level was beyond the scope of the present work.

3.1 Overall Releases During Ramp and Hold Periods

The difference in release predictions due to the increased temperature was noted in the previous section and indicated in Tables 12 and 13. From these same tables, it can be seen that the ramp and hold release predictions of the two models differ at the reference temperature by a factor of about five, and at the higher temperature by a factor of about 8.5. Separating the heatup and the hold components and comparing them individually, it can be seen that at the reference temperature the heatup releases for CURIES-II exceed those of FASTGRASS by a factor of about 3.3; for the hold releases the comparable figure is 7.3. At the higher temperature these two values are 19.4 and 2.9 respectively. The situation is summarized in Table 16. At the lower temperature the hold component is roughly comparable to the ramp component in each of the models. At the higher temperature, one might conclude that the hold release for FASTGRASS is approximately twice the heatup release, while for CURIES-II the hold release is only about one-third the heatup release. However, at the higher temperature, the diffusional

TABLE 12. RAMP + HOLD RELEASES FOR THE REFERENCE TEMPERATURE CASE (Ci I-131)

CHANNEL GROUP (MW)	CURIES-II RAMP + HOLD RELEASES (Ci I-131)	FASTGRASS RAMP + HOLD RELEASES (Ci I-131)
7.5	2.01 +04	2.48 +03
6.7	3.44 +04	7.85 +03
6.2	5.20 +04	1.17 +04
5.7	2.53 +04	4.33 +03
4.6	1.06 +03	44
TOTALS:	1.33 +05	2.64 +04

TABLE 13. RAMP + HOLD RELEASES FOR THE HIGH TEMPERATURE CASE (Ci I-131)

	CURIES-II	FASTGRASS
CHANNEL GROUP (MW)	RAMP + HOLD RELEASES (Ci I-131)	RAMP + HOLD RELEASES (Ci I-131)
7.5	2.11 +05	6.69 +04
6.7	7.21 +05	9.25 +04
6.2	9.74 +05	8.33 +04
5.7	4.84 +05	3.77 +04
4.6	1.06 +03	44
TOTALS:	2.39 +06	2.80 +05

TABLE 14. RELEASES (Ci OF I-131) DUE TO ZR-UO_2 INTERACTION FOR THE REFERENCE AND HIGH TEMPERATURE CASES

CHANNEL GROUP	ZR-UO_2 RELEASES (Ci I-131) HIGH TEMPERATURE	REFERENCE TEMPERATURE
7.5	3.92 +04	2.48 +03
6.7	8.69 +04	7.85 +03
6.2	1.18 +05	1.17 +04
5.7	6.92 +04	4.33 +03
4.6	0.0	0.0
TOTALS:	3.13 +05	2.26 +05

TABLE 15. RAMP + HOLD AND ZR-UO_2 RELEASE PREDICTIONS FOR A 7.5 MW CHANNEL

RAMP + HOLD AND ZR-UO_2 RELEASE PREDICTIONS FROM A 7.5 MW CHANNEL BY REST (CURIES-II) AT REFERENCE AND HIGH TEMPERATURES

	REFERENCE TEMP. RELEASES (Ci I-131)		HIGH TEMP. RELEASES (Ci I-131)	
RING	RAMP + HOLD	ZR-UO_2	RAMP + HOLD	ZR-UO_2
CENTRE	688	314	3139	76
INNER	1325	1977	17651	692
INTER	164	0	2515	2058
OUTER	51	0	47	0

RAMP + HOLD AND ZR-UO_2 RELEASE PREDICTIONS FROM A 7.5 MW CHANNEL BY REST (FASTGRASS) AT REFERENCE AND HIGH TEMPERATURES

	REFERENCE TEMP. RELEASES (Ci I-131)		HIGH TEMP. RELEASES (Ci I-131)	
RING	RAMP + HOLD	ZR-UO_2	RAMP + HOLD	ZR-UO_2
CENTRE	31	314	1723	355
INNER	145	1977	5391	1977
INTER	91	0	305	2028
OUTER	8	0	8	0

TABLE 16. COMPARISON OF RAMP AND HOLD RELEASE PREDICTIONS (Ci I-131) OF THE TWO MODELS AT REFERENCE AND HIGH TEMPERATURES

REFERENCE TEMPERATURE

	RAMP COMPONENT	HOLD COMPONENT
CURIES-II	5.133 +04	8.148 +04
FASTGRASS	1.528 +04	1.112 +04
RATIO*	3.3	7.3

HIGH TEMPERATURE

	RAMP COMPONENT	HOLD COMPONENT
CURIES-II	1.849 +06	5.415 +05
FASTGRASS	9.549 +04	1.849 +05
RATIO*	19.4	2.9

* RATIO = CURIES-II COMPONENT / FASTGRASS COMPONENT

releases during the heatup are so large for CURIES-II that for some elements there is little inventory left at the beginning of the hold period. The number 2.9 in Table 16 may be misleading for this reason.

3.2 Ramp and Hold Releases from the Five Channel Groups

A comparison of the overall ramp and hold release predictions of the two models for the five channels powers, taken individually, is shown in Table 17. In this table, the FASTGRASS prediction has been set to 1.0 in all cases and each entry for CURIES-II shows the factor by which it exceeds the corresponding FASTGRASS prediction. At the level of individual channels, there appears to be no simple explanation that could account for the observed differences from channel to channel.

3.3 Release Fractions During Ramps

A comparison of the release predictions made by the two models during temperature ramps at 1, 5 and 10 K/s is given in Table 18. This table was constructed by dividing each entry in Table 6 by the entry corresponding to the same temperature and ramp rate in Table 8.

Table 18 gives an interesting, if incomplete picture of the variations in the model predictions over a range of conditions. For most of the conditions represented on the table, CURIES-II predicts larger releases than FASTGRASS, in some cases by a wide margin. At temperatures greater than 2300 °C the entries are not particularly meaningful since in this range CURIES-II predicts complete release.

3.4 Release Rates During Hold Periods

From data taken from the runs, equation (1) in section C.5 above was developed to approximate the releases predicted by FASTGRASS during the hold periods. Similarly, for CURIES-II approximate rate constants for release during temperature holds were developed using the coding reproduced in Appendix A.

The two sets of data are presented in Table 19. Both procedures have produced approximate answers that were considered good enough for purposes of this project. It should be noted that the two sets of numbers generated are not strictly comparable. The CURIES-II numbers are rate constants; the FASTGRASS figures represent the release of a fixed fraction per second of the initial inventory. This point needs to be kept in mind when considering the two sets of data shown in Table 19.

TABLE 17. RAMP + HOLD RELEASES (Ci I-131) FOR THE REFERENCE AND HIGH TEMPERATURE CASES

REFERENCE TEMPERATURE CASE

	CURIES-II	FASTGRASS
CHANNEL GROUP	RAMP + HOLD RELEASES	RAMP + HOLD RELEASES
7.5	8.1	1.0
6.7	4.4	1.0
6.2	4.4	1.0
5.7	5.8	1.0
4.6	24.1	1.0

HIGH TEMPERATURE CASE

	CURIES-II	FASTGRASS
CHANNEL GROUP	RAMP + HOLD RELEASES	RAMP + HOLD RELEASES
7.5	3.2	1.0
6.7	7.8	1.0
6.2	11.7	1.0
5.7	12.8	1.0
4.6	24.1	1.0

TABLE 18. COMPARISON OF RELEASE FRACTIONS PREDICTED BY MODELS DURING HEATUP

TEMPERATURE (°C)	RELEASE RATIO* 1 K/S	5 K/S	10 K/S
1100	12.2	12.2	12.2
1150	22.1	5.8	12.4
1200	1.6	2.7	7.3
1250	2.4	2.0	4.4
1300	3.4	1.9	3.2
1350	4.5	1.8	2.8
1400	5.6	1.4	2.2
1450	7.0	1.0	1.5
1500	7.5	0.75	1.0
1550	7.4	0.65	0.78
1600	6.6	0.69	0.68
1650	5.5	0.83	0.70
1700	4.4	1.0	0.80
1750	3.3	1.2	0.94
1800	2.4	1.5	1.3
1850	2.2	2.4	2.1
1900	2.9	5.5	5.1
1950	4.4	12.3	12.4
2000	6.5	24.8	27.8
2050	9.5	45.2	56.6
2100	13.7	75.4	105.0
2150	12.4	73.9	114.0
2200	8.8	53.7	84.9
2250	5.9	35.3	50.7
2300	4.1	22.3	25.7
2350	2.9	13.2	12.2
2400	2.3	7.5	6.3
2450	1.8	4.4	3.7
2500	1.6	2.8	2.5
2550	1.4	2.0	1.8
2600	1.3	1.6	1.5
2650	1.2	1.4	1.3
2700	1.1	1.2	1.2
2750	1.1	1.1	1.1
2800	1.0	1.0	1.0
2850	1.0	1.0	1.0

* RELEASE RATIO
= CURIES-II FRACTION / FASTGRASS FRACTION

4. Components of Total Release

The four components of the release from the fuel (i.e., free inventory, releases during heatup, releases during the hold period and releases due to the Zr-UO_2 interaction), will be considered at two levels. These are

. the overall release for the four cases, and

. the releases per channel from the five representative channel powers.

The components of the overall release for the four cases are shown in Tables 20 and 21. These tables show, respectively, the release values for the four components and the percentage of the total that each component forms. A noteworthy feature is the relatively large fraction of the total that is formed by the Zr-UO_2 component. For the high temperature case with the CURIES-II model, some distortion may be present in the hold and Zr-UO_2 components because of the complete release from some elements predicted during the heatup.

Releases from single channels in each of the five channel powers are shown in Tables 22 to 29. From these tables, the contributions of the four components to the total release from the different channel groups and for the four cases can be seen clearly.

TABLE 19. PREDICTIONS OF FRACTIONAL RELEASE PER SECOND* FOR THE TWO MODELS DURING A HOLD AT TEMPERATURE

	MODEL PREDICTION	
TEMPERATURE (°C)	CURIES-II	FASTGRASS
1000	2.47-07	6.223-10
1400	5.01-06	2.697-08
1500	8.61-06	6.921-08
1600	1.39-05	1.776-07
1700	2.16-05	4.557-07
1800	3.19-05	1.169-06
1900	2.48-04	3.000-06
2000	1.85-03	7.698-06
2100	1.47-02	1.975-05
2200	8.00-02	5.068-05
2300	8.00-02	1.300-04
2400	8.00-02	3.337-04
2500	8.00-02	8.561-04
2600	8.00-02	2.197-03

* THE ENTRIES FOR CURIES-II ARE RATE CONSTANTS; THOSE FOR FASTGRASS REPRESENT A FRACTIONAL RELEASE PER SECOND OF THE INITIAL INVENTORY. SEE TEXT.

TABLE 20. COMPONENTS OF RELEASE FROM ALL CHANNELS : RELEASES OF I-131 (Ci)

	COMPONENT			
CASE*	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
1	1.36 +05	5.13 +04	8.15 +04	2.26 +05
2	1.36 +05	1.53 +04	1.11 +04	2.26 +05
3	1.36 +05	1.85 +06	5.52 +05	3.99 +05
4	1.36 +05	9.55 +04	1.85 +05	3.13 +05

* CASE DEFINITIONS:

CASE 1 : CURIES-II, REFERENCE TEMPERATURE

CASE 2 : FASTGRASS, REFERENCE TEMPERATURE

CASE 3 : CURIES-II, HIGH TEMPERATURE

CASE 4 : FASTGRASS, HIGH TEMPERATURE.

TABLE 21. COMPONENTS OF RELEASE FROM ALL CHANNELS : % OF TOTAL RELEASE

CASE*	COMPONENT			
	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
1	27.3	10.3	16.4	45.5
2	34.9	3.9	2.9	58.2
3	4.7	63.2	18.5	13.6
4	18.6	13.1	25.4	42.9

* CASE DEFINITIONS:

CASE 1 : CURIES-II, REFERENCE TEMPERATURE

CASE 2 : FASTGRASS, REFERENCE TEMPERATURE

CASE 3 : CURIES-II, HIGH TEMPERATURE

CASE 4 : FASTGRASS, HIGH TEMPERATURE.

TABLE 22. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : RELEASES OF I-131 (Ci).

CASE : CURIES-II, REFERENCE TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	3380	1009	1219	2291
6.7	1009	296	435	1535
6.2	350	228	399	1131
5.7	484	159	285	691
4.6	28	8	16	0

TABLE 23. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : % OF TOTAL RELEASE

CASE : CURIES-II, REFERENCE TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	41.5	12.4	15.0	28.1
6.7	30.8	9.0	13.3	46.9
6.2	16.6	10.8	18.9	53.6
5.7	29.9	9.8	17.6	42.7
4.6	53.8	15.4	30.8	0

TABLE 24. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : RELEASES OF I-131 (Ci)

CASE : FASTGRASS, REFERENCE TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	3380	171	104	2291
6.7	1009	109	458	1535
6.2	350	80	61	1131
5.7	484	34	42	691
4.6	28	1	0	0

TABLE 25. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : % OF TOTAL RELEASE

CASE : FASTGRASS, REFERENCE TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	56.8	2.9	1.8	38.5
6.7	37.2	4.0	2.1	56.6
6.2	21.6	4.9	3.8	69.7
5.7	38.7	2.7	3.4	55.2
4.6	96.5	3.4	0	0

TABLE 26. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : RELEASES OF I-131 (Ci)

CASE : CURIES-II, HIGH TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	3380	20507	2845	2796
6.7	1009	14186	1152	988
6.2	350	8312	3425	1270
5.7	484	5386	3102	3887
4.6	28	8	16	0

TABLE 27. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : % OF TOTAL RELEASE

CASE : CURIES-II, HIGH TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	11.4	69.5	9.6	9.5
6.7	5.8	81.8	6.6	5.7
6.2	2.6	62.2	25.6	9.5
5.7	3.8	41.9	24.1	30.2
4.6	53.8	15.4	30.8	0

TABLE 28. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : RELEASES OF I-131 (Ci)

CASE : FASTGRASS, HIGH TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	3380	2287	5140	4360
6.7	1009	681	1287	1850
6.2	350	355	649	1421
5.7	484	235	426	1214
4.6	28	1	0	0

TABLE 29. COMPONENTS OF RELEASE FROM SINGLE CHANNELS FOR THE FIVE CHANNEL POWERS : % OF TOTAL RELEASE

CASE : FASTGRASS, HIGH TEMPERATURE.

	COMPONENT			
CHANNEL	FREE INVENTORY	HEATUP	HOLD	ZR-UO_2
7.5	22.3	15.1	33.9	28.7
6.7	20.9	14.1	26.7	38.3
6.2	12.6	12.8	23.4	51.2
5.7	20.5	9.9	18.0	51.5
4.6	96.5	3.4	0	0

5. Hydrogen Production

Hydrogen production in the channels as a result of the Zr-H_2O reaction over the 1000 second transient is shown in Table 30. For all channels, the hydrogen produced under the high temperature scenario is 21,124 moles. For the reference temperature case, hydrogen production is 11,629 moles over the same period. The amount of hydrogen produced at the higher temperature compared to the reference is increased by a factor of about 1.8.

For individual channels in the five channel power groups, hydrogen production increases by factors of between 1.6 for the 5.7 MW channel to 2.5 for the 7.5 MW channel. Hydrogen production in the 4.6 MW channel was unchanged.

6. Heat Load to the Moderator

Under the high temperature scenario, more heat is rejected to the moderator through the ballooned pressure tubes as a result of higher fuel and gas temperatures. The heat loads to the moderator for the two cases are given in Tables 31 and 32. From these tables it can be seen that the heat load to the moderator increases by about 5%, from 3.94×10^7 kJ to 4.14×10^7 kJ.

The amount of heat rejected by individual channels in the five channel power groups increased by between 4% for the 5.7 MW channel and 8% for the 7.5 MW channel. Heat rejection from the 4.6 MW channel was the same for both the reference and high temperature cases.

TABLE 30. HYDROGEN PRODUCTION IN THE CORE

REFERENCE TEMPERATURE CASE

CHANNEL POWER (MW)	MOLES OF HYDROGEN PRODUCED	NUMBER OF CHANNELS	TOTAL MOLES
7.5	58.4	9	525.6
6.7	52.8	47	2479.2
6.2	60.3	83	5003.6
5.7	48.9	57	2791.9
4.6	18.8	44	828.9
		TOTAL :	11,629.2

HIGH TEMPERATURE CASE

CHANNEL POWER (MW)	MOLES OF HYDROGEN PRODUCED	NUMBER OF CHANNELS	TOTAL MOLES
7.5	146.9	9	1322.5
6.7	122.5	47	5755.2
6.2	103.6	83	8599.6
5.7	81.0	57	4617.6
4.6	18.8	44	828.9
		TOTAL :	21,123.8

TABLE 31. CUMULATIVE HEAT LOSS TO THE MODERATOR AT 1000 SECONDS FOR THE LOW TEMPERATURE CASE

CHANNEL POWER (MW)	HEAT TO MODERATOR (kJ)	NUMBER OF CHANNELS	TOTAL HEAT LOSSES (kJ)
7.5	219,983	9	1.98+06
6.7	198,884	47	9.35+06
6.2	182,355	83	1.51+07
5.7	150,902	57	8.60+06
4.6	99,009	44	4.36+06
		TOTAL :	3.94+07

TABLE 32. CUMULATIVE HEAT LOSS TO THE MODERATOR AT 1000 SECONDS FOR THE HIGH TEMPERATURE CASE

CHANNEL POWER (MW)	HEAT TO MODERATOR (kJ)	NUMBER OF CHANNELS	TOTAL HEAT LOSSES (kJ)
7.5	237,980	9	2.14+06
6.7	213,802	47	1.01+07
6.2	191,188	83	1.59+07
5.7	156,887	57	8.94+06
4.6	99,009	44	4.36+06
		TOTAL :	4.14+07

E. CONCLUSIONS

1. For the versions of CURIES-II and FASTGRASS used in this study and with the temperature scenarios chosen for the work, CURIES-II predicted larger overall releases of fission products from the UO_2 than did FASTGRASS, for both the reference and high temperature cases. The margin between the two codes for release of I-131 at the lower temperature was a factor of approximately 1.3; at the higher temperature this factor was approximately four. (Table 20.) This includes all release components, i.e. those due to free inventory, temperature ramp, temperature hold and Zr-UO_2 interaction.

2. The same free inventory model was used throughout the work. Therefore there was no variation in free inventory with temperature transient or changes of transient release model.

Release due to Zr-UO_2 interaction used the same criterion for both CURIES-II and FASTGRASS and therefore was only dependent on changes in the temperature transients. With the higher temperature scenario, the release due to Zr-UO_2 interaction increased by a factor of about 14. (Table 14.)

Releases due to the temperature ramp and hold varied both with temperature transient and with release model. For CURIES-II, the increase in release due to these two components at the higher temperature was by a factor of about 18. The corresponding figure for FASTGRASS was approximately 10. At the lower temperature, the release predicted by CURIES-II for these two components was a factor of about 5 higher than that of FASTGRASS; at the higher temperature, this factor was about 8.5. (Tables 12, 13.)

3. At the reference temperature, the releases predicted by CURIES-II during the ramp were about 3.3 times greater than those predicted by FASTGRASS. At the higher temperature, the CURIES-II ramp component was 19.4 times that of FASTGRASS. (Table 16.)

4. At constant ramp rates of 1, 5 and 10 K/s, the release fractions during the ramp at temperatures between 1100 and 2500 °C were compared. At most temperatures, CURIES-II predicted larger releases than did FASTGRASS, usually by factors varying between 1 and 10.

In the region of 1500 to 1600 °C, for ramp rates of 5 and 10 K/s, FASTGRASS predicted higher release fractions (by factors of between 1 and 2) than CURIES-II. In the region of 2000 to 2300 °C for ramp rates of 5 and 10 K/s, CURIES-II predicted higher release fractions than FASTGRASS, by factors of roughly 20 and 100.

5. At the reference temperature, releases during the hold period as predicted by CURIES-II were 7.3 times greater than those of FASTGRASS. At the higher temperature CURIES-II predicted 2.9 times greater hold releases than FASTGRASS, although some distortion may be present in this latter figure as indicated in section D of the report. (Table 16.)

6. Overall releases, due to all release components, from single channels for four of the five channel powers were compared. Comparing the CURIES-II release predictions at the higher and lower temperatures, releases from individual channels increased at the higher temperatures by factors of between 3.6 and 7.9, with the greatest increase appearing in the 5.7 MW channel. For FASTGRASS, these increases were by factors of between 1.7 and 2.6, with the greatest increase appearing for the 7.5 MW channel. (Tables 9 and 10.)

At the lower temperatures, releases predicted by CURIES-II from individual channels in the power groups were larger than those predicted by FASTGRASS by factors ranging between 1.2 and 1.4, the greatest difference being for the 7.5 MW channel. At the higher temperatures, CURIES-II predictions exceeded those of FASTGRASS by factors of between 1.9 and 5.5 with the largest increase being for the 5.7 MW channel. (Tables 9 and 10.)

The 4.6 MW channel was excluded from these comparisons since its fuel temperatures did not change in the "higher" temperature case, and since the release from this power group was trivial compared to the others.

7. The percentage contributions to total release provided by the five channel power groups at the lower temperatures were quite similar for both CURIES-II and FASTGRASS. In both cases the 6.2 MW channels released a larger fraction of the total than any other group. At the higher temperatures, the 6.2 MW channels still released more than the other groups in both cases but the percentage contributions to the total had changed considerably. For CURIES-II, the percentage contribution to the total increased for the 6.2 and 5.7 MW groups and decreased for all others. With FASTGRASS, the percentage contributions from the 7.5 and 5.7 MW groups increased and decreased for all others. (Tables 9 and 10.)

8. In a 7.5 MW channel, the sum of the releases (due to ramp and hold) from each ring for all the bundles in the channel were compared. For CURIES-II, the inner rings of the bundles contributed, collectively, a larger fraction of the total release than any other ring. At the higher temperatures, releases from the centre, inner and intermediate rings (summed for each ring over all bundles) increased by factors of 4.6, 13.3 and 15.3 respectively. There was no change in the releases from the outer ring.

For FASTGRASS, the inner rings also made the largest single contribution at both higher and lower temperatures in the 7.5 MW channel. At the higher temperatures, the releases from the centre, inner and intermediate rings increased by factors of 55.6, 37.2 and 3.4 respectively. There was no change in the releases from the outer ring. (Table 15.)

9. At the higher temperature, the amount of hydrogen produced in the core due to the Zr-H_2 reaction increases by a factor of about 1.8 compared with that at the lower temperature. (Table 30.)

10. At the higher temperature, the heat load to the moderator as compared with that at the reference temperature increases by about 5%. (Tables 31 and 32.)

F. REFERENCES

1. V.J. Langman, "Report on a Trip to Argonne National Laboratory, Nov. 1984", Idea Research, Nov. 1984.

2. O. Akalin and J.H.K. Lau, "CHAN-II(MOD4) A Model for Analysis of Channel Thermal Response Under Steam Cooling Conditions", OH Report 82014, February 1982.

3. V.J. Langman and K.R. Weaver, "An Assessment of Selected Factors Related to Fuel and Pressure Tube Behaviour in Large Break LOCAs with Potentially Delayed ECI", AECB Report INFO-0114-5 (In press).

4. G.H. Archinoff, "CURIES-II: A Fission Product Distribution and Release Code", Ontario Hydro D&D Report No. 83057, March 1983.

5. J. Rest, "An Improved Model for Fission Product Behaviour in Nuclear Fuel Under Normal and Accident Conditions", J. Nuclear Materials, 120 (1984) 195-212.

APPENDIX A : CODE MODIFICATIONS

Modifications were made both to CHAN and to CURIES-II. Although they were minor changes in the case of both codes, they are described here.

A. CHAN MODIFICATIONS

Two sorts of modification were made to CHAN. The first was not really a code modification; it was a change in input data used to obtain the high temperature transient results. This has already been discussed in section C.2 in the main report. The second group of modifications was cosmetic, in that it rearranged some of the output but did not affect the actual calculations. These latter modifications will now be described.

Normally, CHAN provides fuel temperatures and other data for all the fuel bundles in the channel at each print step. Consequently, to follow the temperature history of a given bundles or ring, one has to examine all print steps in the run. For this work, additional print statements and a separate subroutine to accommodate them were inserted into the code. The normal CHAN output is unaffected but a further set of 13 tables are now produced at each run. In each of these tables, the fuel temperatures for all the rings (contact and non-contact zones) in a bundle for all the print steps in the run are collected and printed together. This makes the task of finding peak temperatures and their corresponding times much easier and presents a clearer summary of the temperature histories in each bundle throughout the transient.

B. MODIFICATIONS RELATING TO CURIES-II

1. Ramp Releases

In order to obtain the constant temperature ramp calculations in CURIES-II, several lines of coding were inserted to determine the new temperature internally in the code at each step in the calculation. This avoided having large amounts of input data and allowed the constant ramp rate runs to be initiated using only three input numbers: the initial temperature, the ramp rate (K/s) and the final temperature.

2. Hold Releases

As described in the main report, one of the release components calculated by REST is the release during the constant temperature hold period, for which a rate constant approach was adopted. To derive these rate constants, the coding that is used in CURIES-II for diffusional release from the grains was coded in BASIC and run on a micro-computer. The equations and the coded version of them are shown in Tables A.1 and A.2 below.

TABLE A.1. DIFFUSIONAL RELEASE EQUATIONS

For $T < 2073$ K,

$$f = 1.03 \left(t \exp(-32070/T) \right)^{1/2} \quad c < 1$$

$$f = 1.0 - 0.608 \exp\left(-0.919\, t \exp(-32070/T)\right) \quad c > 1$$

$$c = 0.919\, t \exp(-32070/T)$$

For $2073 \text{ K} < T < 2673$ K,

$$f = 6.63 \times 10^{15} \left(t \exp(-183000/T) \right)^{1/2} \quad c < 1$$

$$f = 1.0 - 0.608 \exp\left(-3.79 \times 10^{31}\, t \exp(-183000/T)\right) \quad c > 1$$

$$c = 3.79 \times 10^{31}\, t \exp(-183000/T)$$

TABLE A.2. RELEASES DURING CONSTANT TEMPERATURE HOLD

```
10 REM CURIES-II HOLD RELEASES
20 REM
30 READ K
40 DATA 2473.
50 PRINT "TEMP (K) = ", K
60 LPRINT "TEMP (K) = ", K
70 LET K1=-183000./K
80 LET K2=-32070./K
90 LET K1=EXP(K1)
100 LET K2=EXP(K2)
110 LET T=200.
120 PRINT "TIME (S)", "RELEASE FR.", "LN(F)/TIME"
130 LPRINT "TIME (S)", "RELEASE FR.", "LN(F)/TIME"
140 FOR I=1 TO 14
150 LET C=3.79E+31*T*K1
160 IF K<2073. GOTO 300
170 IF C>1. GOTO 230
180 REM
190 REM T IS > 2073, C IS < 1
200 REM
210 LET F=6.63E+15*(T*K1)**.5
220 GOTO 430
230 REM
240 REM T IS >= 2073, C IS > 1
250 REM
260 LET X=-3.79E+31*T*K1
270 LET X=.608*EXP(X)
280 LET F=1.-X
290 GOTO 430
300 LET C=.919*T*K2
310 IF C>1. GOTO 380
320 REM
330 REM T IS <= 2073, C IS <= 1
340 REM
350 LET X=(T*K2)**.5
360 LET F=1.03*X
370 GOTO 430
380 REM
390 REM T IS <= 2073, C IS > 1
400 REM
```

```
410 LET X=.608*EXP(-.919*T*K2)
420 LET F=1.-X
430 LET F1=1.-F
440 LET L=-LOG(F1)/T
450 REM
460 REM PRINTING OUTPUT
470 REM
480 PRINT T, F, L
490 LPRINT T, F, L
500 LET T=T+100.
510 NEXT I
520 END
```

NOMENCLATURE

VARIABLE	DESCRIPTION
K	Absolute temperature.
T	Time in seconds.
C	As given in the equations in Table A.1.
X	Fraction of inventory released.
F1	Fraction of inventory retained in grains.
L	Rate constant for release.
K1, K2, F	Intermediate variables.

APPENDIX B. CHANNEL TEMPERATURE DATA

In the following tables, the data that was selected from the two sets of CHAN runs is listed. Included in these data are the fuel temperatures in the contact zones, although only the non-contact fuel temperatures were used as input to REST. For each bundle, the input to REST consists of the 20 numbers in columns one to four. A dash entered at any point in the table represents a zero for that particular entry.

The cases to which the tables refer are identified below. The files that contain the input data to REST (and which is taken from the tables in this appendix) are identified in Appendix D.

Tables B. 1 to 13	7.5 MW Channel, Reference Case
Tables B. 14 to 26	6.7 MW Channel, Reference Case
Tables B. 27 to 39	6.2 MW Channel, Reference Case
Tables B. 40 to 52	5.7 MW Channel, Reference Case
Tables B. 53 to 65	4.6 MW Channel, Reference Case
Tables B. 66 to 78	7.5 MW Channel, High Temp Case
Tables B. 79 to 91	6.7 MW Channel, High Temp Case
Tables B. 92 to 104	6.2 MW Channel, High Temp Case
Tables B.105 to 117	5.7 MW Channel, High Temp Case
Tables B.118 to 130	4.6 MW Channel, High Temp Case

TABLE B.1. BUNDLE NO. 1 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	0	0	0	0	-	-	-
TPMAXF	378	383	395	416	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.2. BUNDLE NO. 2 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	563	574	622	700	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.3. BUNDLE NO. 3 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	797	792	861	1020	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.4. BUNDLE NO. 4 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	875	919	1045	-	-	1045	919
TIMAXF	250	250	150	0	0	250	250
TPMAXF	1844	1696	1333	1246	1246	1336	1697
TIHOLD	50	50	250	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.5. BUNDLE NO. 5 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	919	965	1099	-	-	1099	965
TIMAXF	200	200	150	0	50	150	150
TPMAXF	1928	1886	1633	1423	1423	1611	1865
TIHOLD	50	100	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.6. BUNDLE NO. 6 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	992	1044	1190	-	-	1190	1044
TIMAXF	200	150	100	0	50	100	150
TPMAXF	1967	1898	1702	1423	1423	1680	1873
TIHOLD	100	50	50	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.7. BUNDLE NO. 7 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	50	50
TPFHS	996	1048	1195	-	-	1634	1561
TIMAXF	200	200	100	0	50	100	150
TPMAXF	2011	1948	1771	1430	1202	1736	1911
TIHOLD	100	100	50	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.8. BUNDLE NO. 8 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	1024	1077	1229	-	-	1229	1077
TIMAXF	200	200	100	0	0	100	100
TPMAXF	2033	1975	1789	1471	1471	1769	1932
TIHOLD	50	50	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.9. BUNDLE NO. 9 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	961	1010	1151	-	-	1151	1010
TIMAXF	200	200	150	0	0	100	150
TPMAXF	1973	1907	1698	1375	1375	1673	1887
TIHOLD	50	50	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.10. BUNDLE NO. 10 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	942	990	1127	-	-	1127	990
TIMAXF	200	200	150	0	0	150	150
TPMAXF	1946	1880	1677	1346	1346	1657	1873
TIHOLD	50	100	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.11. BUNDLE NO. 11 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	789	828	938	-	-	938	828
TIMAXF	250	250	250	0	0	200	200
TPMAXF	1912	1873	1613	1114	1114	1594	1859
TIHOLD	50	100	100	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.12. BUNDLE NO. 12 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	584	602	656	741	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	811	832	865	855	-	-	-
TIHOLD	50	50	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.13. BUNDLE NO. 13 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	385	390	404	426	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	693	697	712	708	-	-	-
TIHOLD	100	100	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.14. BUNDLE NO. 1 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	356	357	366	380	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.15. BUNDLE NO. 2 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	543	545	588	657	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.16. BUNDLE NO. 3 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	779	771	810	956	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE
2 = INTERMEDIATE
3 = INNER
4 = OUTER
} NON-CONTACT

5 = OUTER
6 = INTERMEDIATE
7 = INNER
} CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.17. BUNDLE NO. 4 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	823	863	979	-	-	979	863
TIMAXF	300	250	200	0	0	200	250
TPMAXF	1496	1419	1220	1164	1164	1220	1419
TIHOLD	100	150	100	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.18. BUNDLE NO. 5 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	863	906	1029	-	-	1029	906
TIMAXF	200	200	200	0	0	200	200
TPMAXF	1838	1728	1409	1225	1225	1401	1728
TIHOLD	50	50	100	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.19. BUNDLE NO. 6 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	929	976	1111	-	-	1111	976
TIMAXF	200	150	150	0	0	150	150
TPMAXF	1916	1866	1623	1326	1326	1587	1862
TIHOLD	100	50	50	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.20. BUNDLE NO. 7 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	932	980	1115	-	-	1115	980
TIMAXF	200	150	100	0	0	100	150
TPMAXF	1931	1868	1663	1331	1331	1673	1857
TIHOLD	100	100	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.21. BUNDLE NO. 8 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	950	999	1137	-	-	1137	999
TIMAXF	200	150	100	0	0	100	150
TPMAXF	1947	1880	1696	1358	1358	1695	1866
TIHOLD	150	100	50	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.22. BUNDLE NO. 9 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	894	939	1068	-	-	1068	939
TIMAXF	200	150	150	0	0	100	150
TPMAXF	1928	1866	1648	1272	1272	1612	1864
TIHOLD	150	100	50	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.23. BUNDLE NO. 10 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	869	913	1037	-	-	1037	913
TIMAXF	200	150	150	0	0	150	150
TPMAXF	1919	1865	1648	1235	1235	1636	1863
TIHOLD	50	100	50	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.24. BUNDLE NO. 11 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	748	778	865	-	-	865	778
TIMAXF	200	300	300	0	0	250	250
TPMAXF	1847	1792	1515	1025	1025	1453	1774
TIHOLD	100	150	150	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.25. BUNDLE NO. 12 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	550	566	614	689	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	799	822	858	845	-	-	-
TIHOLD	50	50	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.26. BUNDLE NO. 13 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	358	361	371	386	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	676	683	698	692	-	-	-
TIHOLD	150	100	100	100	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.27. BUNDLE NO. 1 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	354	352	360	373	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.28. BUNDLE NO. 2 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	530	523	560	623	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.29. BUNDLE NO. 3 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	741	734	767	887	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.30. BUNDLE NO. 4 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	926	926	950	1081	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.31. BUNDLE NO. 5 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	804	844	957	-	-	957	844
TIMAXF	250	250	150	0	0	150	250
TPMAXF	1567	1489	1290	1138	1138	1291	1489
TIHOLD	100	100	100	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.32. BUNDLE NO. 6 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	867	910	1034	1232	1232	1480	1786
TIMAXF	250	250	250	0	0	200	250
TPMAXF	1849	1816	1542	1232	1232	1480	1786
TIHOLD	250	250	250	0	0	200	250

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.33. BUNDLE NO. 7 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	871	914	1039	-	-	1039	914
TIMAXF	250	200	200	0	0	150	200
TPMAXF	1923	1874	1621	1238	1238	1557	1863
TIHOLD	150	100	100	0	0	150	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.34. BUNDLE NO. 8 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	886	931	1058	-	-	1058	931
TIMAXF	200	150	150	0	0	150	150
TPMAXF	1924	1869	1646	1261	1261	1635	1870
TIHOLD	100	100	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	NON-CONTACT
3 = INNER	NON-CONTACT
4 = OUTER	NON-CONTACT
5 = OUTER	CONTACT
6 = INTERMEDIATE	CONTACT
7 = INNER	CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.35. BUNDLE NO. 9 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	833	874	993	-	-	993	874
TIMAXF	250	200	200	0	0	150	200
TPMAXF	1931	1882	1633	1181	1181	1584	1874
TIHOLD	150	100	100	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.36. BUNDLE NO. 10 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	810	850	964	-	-	964	850
TIMAXF	250	250	200	0	0	200	200
TPMAXF	1913	1866	1601	1145	1145	1584	1864
TIHOLD	100	100	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.37. BUNDLE NO. 11 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	706	733	804	-	-	804	733
TIMAXF	350	350	350	50	50	350	350
TPMAXF	1844	1699	1343	957	958	1343	1699
TIHOLD	100	150	150	0	0	150	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.38. BUNDLE NO. 12 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	525	540	583	651	-	-	-
TIMAXF	100	50	50	50	-	-	-
TPMAXF	749	797	834	823	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.39. BUNDLE NO. 13 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	353	356	365	379	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	653	663	676	671	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.40. BUNDLE NO. 1 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	337	337	343	352	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.41. BUNDLE NO. 2 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	466	467	497	545	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.42. BUNDLE NO. 3 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	602	622	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	636	630	678	769	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.43. BUNDLE NO. 4 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	723	753	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	803	801	834	987	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.44. BUNDLE NO. 5 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	806	846	960	-	-	960	846
TIMAXF	300	300	200	0	0	200	300
TPMAXF	1455	1381	1192	1141	1141	1192	1381
TIHOLD	150	150	200	0	0	200	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.45. BUNDLE NO. 6 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	889	934	1063	-	-	1063	934
TIMAXF	200	200	250	0	0	200	200
TPMAXF	1853	1725	1412	1267	0.0	1393	1726
TIHOLD	50	100	150	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.46. BUNDLE NO. 7 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	906	952	1083	-	-	1083	952
TIMAXF	250	200	200	0	0	200	200
TPMAXF	1917	1866	1608	1292	1292	1552	1862
TIHOLD	150	100	100	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.47. BUNDLE NO. 8 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	889	934	1062	-	-	1062	934
TIMAXF	250	250	200	0	0	200	200
TPMAXF	1939	1889	1630	1266	1266	1566	1873
TIHOLD	100	150	100	0	0	100	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.48. BUNDLE NO. 9 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	809	849	963	-	-	963	849
TIMAXF	300	300	300	0	0	250	250
TPMAXF	1873	1840	1560	1145	0.0	1486	1807
TIHOLD	100	100	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.49. BUNDLE NO. 10 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	734	762	848	-	-	848	762
TIMAXF	350	400	400	0	0	350	400
TPMAXF	1836	1675	1320	1004	1004	1312	1674
TIHOLD	100	150	150	0	0	150	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.50. BUNDLE NO. 11 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	616	637	697	792	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	844	860	889	871	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.51. BUNDLE NO. 12 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	410	413	439	473	-	-	-
TIMAXF	100	100	100	50	-	-	-
TPMAXF	728	735	743	738	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.52. BUNDLE NO. 13 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	337	339	345	355	-	-	-
TIMAXF	150	150	150	150	-	-	-
TPMAXF	669	676	682	675	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.53. BUNDLE NO. 1 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	332	331	334	342	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.54. BUNDLE NO. 2 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	430	433	457	496	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.55. BUNDLE NO. 3 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	563	558	601	674	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.56. BUNDLE NO. 4 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	694	692	723	625	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE
2 = INTERMEDIATE
3 = INNER
4 = OUTER
} NON-CONTACT

5 = OUTER
6 = INTERMEDIATE
7 = INNER
} CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.57. BUNDLE NO. 5 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	50	0	-	-	-
TPMAXF	809	812	838	949	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.58. BUNDLE NO. 6 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	758	784	887	-	-	887	784
TIMAXF	350	300	250	0	0	250	300
TPMAXF	1362	1299	1131	1053	1053	1131	1299
TIHOLD	150	150	150	0	0	150	200

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.59. BUNDLE NO. 7 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	761	798	904	-	-	904	798
TIMAXF	300	300	200	0	0	200	300
TPMAXF	1487	1408	1203	1073	1073	1204	1408
TIHOLD	150	150	200	0	0	200	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.60. BUNDLE NO. 8 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	758	783	887	-	-	887	783
TIMAXF	300	300	250	0	0	250	300
TPMAXF	1534	1451	1229	1052	1052	1229	1451
TIHOLD	200	200	250	0	0	250	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.61. BUNDLE NO. 9 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	705	731	805	-	-	805	731
TIMAXF	350	300	250	0	0	250	300
TPMAXF	1458	1382	1174	952	952	1174	1382
TIHOLD	150	200	200	0	0	200	200

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.62. BUNDLE NO. 10 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	858	877	908	889	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.63. BUNDLE NO. 11 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	100	100	50	50	-	-	-
TPMAXF	817	815	843	832	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.64. BUNDLE NO. 12 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	150	150	100	100	-	-	-
TPMAXF	743	744	756	748	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.65. BUNDLE NO. 13 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	200	200	150	150	-	-	-
TPMAXF	701	703	710	703	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.66. BUNDLE NO. 1 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	0	0	0	0	-	-	-
TPMAXF	378	383	395	416	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.67. BUNDLE NO. 2 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	563	574	622	700	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.68. BUNDLE NO. 3 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	797	792	861	1020	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.69. BUNDLE NO. 4 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	875	919	1045	-	-	1045	919
TIMAXF	300	300	300	0	0	250	300
TPMAXF	1916	1731	1342	1246	1246	1336	1723
TIHOLD	100	150	350	0	0	200	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.70. BUNDLE NO. 5 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	919	965	1099	-	-	1099	965
TIMAXF	250	250	200	0	0	150	250
TPMAXF	2241	2108	1690	1312	1312	1623	2069
TIHOLD	100	100	100	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.71. BUNDLE NO. 6 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	992	1044	1190	-	-	1190	1044
TIMAXF	250	250	200	0	0	50	250
TPMAXF	2401	2282	1891	1423	1423	1756	2202
TIHOLD	100	100	150	0	0	50	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.72. BUNDLE NO. 7 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	996	1048	1195	-	-	1634	1561
TIMAXF	300	300	200	0	0	100	250
TPMAXF	2459	2336	1950	1430	1430	1815	2248
TIHOLD	100	150	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE 8.73. BUNDLE NO. 8 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	1024	1077	1229	-	-	1229	1077
TIMAXF	350	350	250	0	0	100	350
TPMAXF	2467	2343	1950	1471	1471	1788	2243
TIHOLD	150	150	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.74. BUNDLE NO. 9 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	961	1010	1151	-	-	1151	1010
TIMAXF	450	450	350	0	0	150	400
TPMAXF	2377	2240	1823	1375	1375	1628	2156
TIHOLD	150	150	200	0	0	100	200

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.75. BUNDLE NO. 10 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	942	990	1127	-	-	1127	990
TIMAXF	500	500	450	0	0	200	500
TPMAXF	2292	2159	1742	1346	1346	1565	2077
TIHOLD	100	150	200	0	0	450	150

RING IDENTIFICATION:

1 = CENTRE
2 = INTERMEDIATE
3 = INNER
4 = OUTER
) NON-CONTACT

5 = OUTER
6 = INTERMEDIATE
7 = INNER
) CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.76. BUNDLE NO. 11 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	789	828	938	-	-	938	828
TIMAXF	600	600	600	0	0	400	550
TPMAXF	2108	1967	1561	1114	1114	1479	1895
TIHOLD	150	150	200	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.77. BUNDLE NO. 12 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	584	602	656	741	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	811	832	865	855	-	-	-
TIHOLD	50	50	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.78. BUNDLE NO. 13 7.5 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	385	390	404	426	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	691	697	712	707	-	-	-
TIHOLD	100	100	100	100	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.79. BUNDLE NO. 1 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	356	357	366	380	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.80. BUNDLE NO. 2 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	543	545	588	657	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	NON-CONTACT
3 = INNER	NON-CONTACT
4 = OUTER	NON-CONTACT
5 = OUTER	CONTACT
6 = INTERMEDIATE	CONTACT
7 = INNER	CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.81. BUNDLE NO. 3 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	779	771	809	956	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.82. BUNDLE NO. 4 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	823	863	979	-	-	979	863
TIMAXF	300	250	200	0	0	200	250
TPMAXF	1496	1419	1220	1164	1164	1220	1419
TIHOLD	100	150	100	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.83. BUNDLE NO. 5 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	863	906	1029	-	-	1029	906
TIMAXF	300	300	300	0	0	200	250
TPMAXF	2030	1904	1507	1225	1225	1398	1827
TIHOLD	100	50	50	0	0	50	50

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.84. BUNDLE NO. 6 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	929	976	1111	-	-	1111	976
TIMAXF	250	250	200	0	0	150	250
TPMAXF	2280	2146	1726	1326	1326	1661	2103
TIHOLD	50	100	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.85. BUNDLE NO. 7 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	932	980	1115	-	-	1115	980
TIMAXF	300	250	250	0	0	150	250
TPMAXF	2342	2207	1791	1331	1331	1696	2153
TIHOLD	100	50	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.86. BUNDLE NO. 8 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	950	999	1137	-	-	1137	999
TIMAXF	300	300	250	0	0	100	300
TPMAXF	2364	2231	1816	1358	1358	1703	2158
TIHOLD	150	100	100	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.87. BUNDLE NO. 9 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	894	939	1068	-	-	1068	939
TIMAXF	350	350	300	0	0	150	350
TPMAXF	2301	2168	1755	1272	1272	1652	2098
TIHOLD	100	150	150	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.88. BUNDLE NO. 10 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	869	913	1037	-	-	1037	913
TIMAXF	450	400	350	0	0	150	400
TPMAXF	2232	2094	1690	1235	1235	1577	2014
TIHOLD	150	200	200	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.89. BUNDLE NO. 11 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	748	778	865	-	-	865	778
TIMAXF	500	550	550	0	0	250	500
TPMAXF	1909	1754	1376	1025	1025	1368	1719
TIHOLD	200	150	500	0	0	250	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.90. BUNDLE NO. 12 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	550	566	614	689	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	799	822	858	844	-	-	-
TIHOLD	50	50	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE
2 = INTERMEDIATE
3 = INNER
4 = OUTER
) NON-CONTACT

5 = OUTER
6 = INTERMEDIATE
7 = INNER
) CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.91. BUNDLE NO. 13 6.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	0	-	-	-
TPFHS	358	361	371	386	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	676	683	698	692	-	-	-
TIHOLD	50	50	50	50	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.92. BUNDLE NO. 1 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	354	352	360	373	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.93. BUNDLE NO. 2 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	530	523	560	623	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.94. BUNDLE NO. 3 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	741	734	767	887	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.97. BUNDLE NO. 4 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	926	926	950	1081	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.96. BUNDLE NO. 5 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	804	844	957	-	-	957	844
TIMAXF	250	250	150	0	0	150	250
TPMAXF	1567	1489	1290	1138	1138	1291	1489
TIHOLD	150	150	150	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.97. BUNDLE NO. 6 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	867	910	1034	1232	1232	1480	1786
TIMAXF	300	300	300	0	0	250	250
TPMAXF	2125	2005	1603	1232	1232	1485	1946
TIHOLD	100	100	150	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.98. BUNDLE NO. 7 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	871	914	1039	-	-	1039	914
TIMAXF	300	300	250	0	0	200	250
TPMAXF	2233	2101	1687	1238	1238	1591	2058
TIHOLD	150	150	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.101. BUNDLE NO. 8 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	886	931	1058	-	-	1058	931
TIMAXF	300	300	250	0	0	150	250
TPMAXF	2282	2148	1731	1261	1261	1646	2092
TIHOLD	100	150	200	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.100. BUNDLE NO. 9 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	833	874	993	-	-	993	874
TIMAXF	350	350	300	0	0	200	300
TPMAXF	2241	2103	1690	1181	1181	1602	2043
TIHOLD	150	150	100	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.101. BUNDLE NO. 10 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	810	850	964	-	-	964	850
TIMAXF	400	400	350	0	0	200	350
TPMAXF	2176	2042	1635	1145	1145	1532	1963
TIHOLD	100	150	150	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.102. BUNDLE NO. 11 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	706	733	804	-	-	804	733
TIMAXF	450	450	450	50	50	450	450
TPMAXF	1832	1667	1311	957	958	1311	1667
TIHOLD	100	150	250	0	0	400	200

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.103. BUNDLE NO. 12 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	525	540	583	651	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	774	797	834	823	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.104. BUNDLE NO. 13 6.2 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	353	356	365	379	-	-	-
TIMAXF	150	100	100	100	-	-	-
TPMAXF	653	663	677	671	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.105. BUNDLE NO. 1 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	337	337	343	352	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.106. BUNDLE NO. 2 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	466	467	497	545	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.107. BUNDLE NO. 3 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	636	630	678	769	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.108. BUNDLE NO. 4 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	803	801	834	987	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.109. BUNDLE NO. 5 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	806	846	960	-	-	960	846
TIMAXF	300	300	200	0	0	200	300
TPMAXF	1455	1381	1192	1141	1141	1192	1381
TIHOLD	150	150	200	0	0	200	150

RING IDENTIFICATION:

1 = CENTRE	)
2 = INTERMEDIATE	) NON-
3 = INNER	) CONTACT
4 = OUTER	)
5 = OUTER	)
6 = INTERMEDIATE	) CONTACT
7 = INNER	)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.110. BUNDLE NO. 6 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	889	934	1063	-	-	1063	934
TIMAXF	300	350	350	0	0	200	250
TPMAXF	2026	1906	1517	1267	1267	1391	1821
TIHOLD	200	100	150	0	0	150	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.111. BUNDLE NO. 7 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	906	952	1083	-	-	1083	952
TIMAXF	300	300	300	0	0	200	250
TPMAXF	2220	2089	1672	1292	1292	1573	2046
TIHOLD	150	150	100	0	0	100	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.112. BUNDLE NO. 8 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	889	934	1062	-	-	1062	934
TIMAXF	300	300	300	0	0	200	300
TPMAXF	2255	2123	1707	1266	1266	1602	2074
TIHOLD	100	150	150	0	0	100	150

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.113. BUNDLE NO. 9 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	809	849	963	-	-	963	849
TIMAXF	400	400	400	0	0	250	350
TPMAXF	2160	2034	1630	1145	1145	1506	1974
TIHOLD	150	150	150	0	0	50	100

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.114. BUNDLE NO. 10 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	734	762	848	-	-	848	762
TIMAXF	450	450	450	0	0	400	450
TPMAXF	1857	1690	1329	1004	1004	1320	1689
TIHOLD	150	150	200	0	0	150	100

RING IDENTIFICATION:

1 = CENTRE
2 = INTERMEDIATE
3 = INNER
4 = OUTER
) NON-CONTACT

5 = OUTER
6 = INTERMEDIATE
7 = INNER
) CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.115. BUNDLE NO. 11 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	616	637	697	792	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	844	860	889	871	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.116. BUNDLE NO. 12 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	410	418	439	473	-	-	-
TIMAXF	100	100	100	50	-	-	-
TPMAXF	728	735	743	738	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.117. BUNDLE NO. 13 5.7 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	337	339	345	355	-	-	-
TIMAXF	150	150	150	150	-	-	-
TPMAXF	669	676	682	675	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.118. BUNDLE NO. 1 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	332	331	334	342	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.119. BUNDLE NO. 2 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	0	0	0	-	-	-
TPMAXF	430	433	457	496	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.120. BUNDLE NO. 3 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	563	558	601	674	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.121. BUNDLE NO. 4 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	0	0	-	-	-
TPMAXF	694	692	723	825	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.122. BUNDLE NO. 5 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	50	0	-	-	-
TPMAXF	809	812	838	949	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.123. BUNDLE NO. 6 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	758	784	887	-	-	887	784
TIMAXF	350	300	250	0	0	250	300
TPMAXF	1362	1299	1131	1053	1053	1131	1299
TIHOLD	150	150	150	0	0	150	200

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.124. BUNDLE NO. 7 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	761	798	904	-	-	904	798
TIMAXF	300	300	200	0	0	200	300
TPMAXF	1487	1408	1203	1073	1073	1204	1408
TIHOLD	150	150	200	0	0	200	150

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.125. BUNDLE NO. 8 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	758	783	887	-	-	887	783
TIMAXF	300	300	250	0	0	250	300
TPMAXF	1534	1451	1229	1052	1052	1229	1451
TIHOLD	200	200	250	0	0	250	150

RING IDENTIFICATION:

1 = CENTRE	NON-CONTACT
2 = INTERMEDIATE	
3 = INNER	
4 = OUTER	
5 = OUTER	CONTACT
6 = INTERMEDIATE	
7 = INNER	

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.126. BUNDLE NO. 9 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	0	0	0	-	-	0	0
TPFHS	705	731	805	-	-	805	731
TIMAXF	350	300	250	0	0	250	300
TPMAXF	1458	1382	1174	952	952	1174	1382
TIHOLD	150	200	200	0	0	200	200

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.127. BUNDLE NO. 10 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	50	50	50	50	-	-	-
TPMAXF	858	877	908	889	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.128. BUNDLE NO. 11 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	100	100	50	50	-	-	-
TPMAXF	817	815	843	833	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.129. BUNDLE NO. 12 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	150	150	100	100	-	-	-
TPMAXF	743	744	756	748	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE)
2 = INTERMEDIATE) NON-
3 = INNER) CONTACT
4 = OUTER)

5 = OUTER)
6 = INTERMEDIATE) CONTACT
7 = INNER)

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

TABLE B.130. BUNDLE NO. 13 4.6 MW CHANNEL

	RING						
	1	2	3	4	5	6	7
TIFHS	-	-	-	-	-	-	-
TPFHS	-	-	-	-	-	-	-
TIMAXF	200	200	150	150	-	-	-
TPMAXF	701	703	710	703	-	-	-
TIHOLD	0	0	0	0	-	-	-

RING IDENTIFICATION:

1 = CENTRE 2 = INTERMEDIATE 3 = INNER 4 = OUTER	NON-CONTACT
5 = OUTER 6 = INTERMEDIATE 7 = INNER	CONTACT

VARIABLES:

TIFHS = TIME AT BEGINNING OF RAMP

TPFHS = TEMP. AT BEGINNING OF RAMP

TIMAXF = TIME AT END OF RAMP

TPMAXF = TEMP. AT END OF RAMP

TIHOLD = TIME AT TPMAXF

APPENDIX C : SELECTED CODE OUTPUT

In this Appendix, a selection of the input and output data for the runs is included to provide a fuller indication of some of the release trends. These are summarized in very abbreviated form in the main report, e.g. in tables such as Table 8.

A. FASTGRASS INPUT: MAJOR PARAMETERS

TABLE C.1 FASTGRASS CALCULATIONS (MAJOR PARAMETERS)

	STEADY STATE PARAMETERS			TRANSIENT PARAMETERS	
LINEAR POWER	TEMP.	TEMP. GRADIENT	RAMP RATE	PEAK TEMP.	TEMP. GRADIENT
60	2300	2500	5	2500	2500
60	2300	2500	5	3000	2500
60	1800	2500	5	2000	2500
60	1800	2500	5	2500	2500
60	1800	2500	5	3000	2500
60	1300	2500	5	2000	2500
60	1300	2500	5	2500	2500
60	1300	2500	5	3000	2500
40	1400	1300	5	2000	1300
40	1400	1300	5	2500	1300
40	1400	1300	5	3000	1300
40	1000	1300	5	2000	1300
40	1000	1300	5	2500	1300
40	1000	1300	5	3000	1300
30	1100	900	5	2000	900
30	1100	900	5	2500	900
30	1100	900	5	3000	900
20	800	550	5	2000	550
20	800	550	5	2500	550
20	800	550	5	3000	550
60	1300	2500	5	2000	200
60	1300	2500	5	2500	200
60	1300	2500	5	3000	200

TABLE C.1 (Continued) FASTGRASS CALCULATIONS

(MAJOR PARAMETERS)

	STEADY STATE PARAMETERS			TRANSIENT PARAMETERS	
LINEAR POWER	TEMP.	TEMP. GRADIENT	RAMP RATE	PEAK TEMP.	TEMP. GRADIENT
60	2300	2500	5	2500	200
60	2300	2500	5	3000	200
60	1800	2500	5	2000	200
60	1800	2500	5	2500	200
60	1800	2500	5	3000	200
60	1300	2500	5	2000	200
60	1300	2500	5	2500	200
60	1300	2500	5	3000	200
40	1400	1300	5	2000	200
40	1400	1300	5	2500	200
40	1400	1300	5	3000	200
40	1000	1300	5	2000	200
40	1000	1300	5	2500	200
40	1000	1300	5	3000	200
30	1100	900	5	2000	200
30	1100	900	5	2500	200
30	1100	900	5	3000	200
20	800	550	5	2000	200
20	800	550	5	2500	200
20	800	550	5	3000	200

TABLE C.1 (Continued) FASTGRASS CALCULATIONS

(MAJOR PARAMETERS)

STEADY STATE PARAMETERS			TRANSIENT PARAMETERS		
LINEAR POWER	TEMP.	TEMP. GRADIENT	RAMP RATE	PEAK TEMP.	TEMP. GRADIENT
40	1400	1300	1	2300	200
40	1400	1300	1	2500	200
40	1400	1300	1	2700	200
40	1400	1300	1	3000	200
40	1400	1300	5	2100	200
40	1400	1300	5	2200	200
40	1400	1300	5	2300	200
40	1400	1300	5	2400	200
40	1400	1300	5	2700	200
40	1400	1300	10	2300	200
40	1400	1300	10	2500	200
40	1400	1300	10	2700	200
40	1400	1300	10	3000	200

B. FASTGRASS RELEASE PREDICTIONS

TABLE C.2. CASE : 1 K/S, PEAK TEMP. 2300 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	50	9.249-05
1500	100	9.351-05
1550	150	9.447-05
1600	200	9.673-05
1650	250	1.108-04
1700	300	1.125-04
1750	350	1.345-04
1800	400	1.755-04
1850	450	2.425-04
1900	500	3.599-04
1950	550	5.663-04
2000	600	9.233-04
2050	650	1.538-03
2100	700	2.599-03
2150	750	4.438-03
2200	800	7.617-03
2250	850	1.303-02
2300	900	2.201-02
HOLD PERIOD		
2300	1000	4.055-02
2300	1100	5.808-02
2300	1200	7.804-02
2300	1300	9.906-02
2300	1400	1.198-01
2300	1500	1.410-01
2300	1600	1.623-01
2300	1700	1.829-01
2300	1800	2.029-01
2300	1900	2.371-01

TABLE C.3. CASE : 1 K/S, PEAK TEMP. 2500 K

TEMPERATURE	TRANSIENT TIME	IODINE RELEASE
RAMP PERIOD		
1400	0	4.909-06
1450	50	9.249-05
1500	100	9.351-05
1550	150	9.447-05
1600	200	9.673-05
1650	250	1.108-04
1700	300	1.125-04
1750	350	1.345-04
1800	400	1.755-04
1850	450	2.425-04
1900	500	3.599-04
1950	550	5.663-04
2000	600	9.233-04
2050	650	1.538-03
2100	700	2.599-03
2150	750	4.438-03
2200	800	7.617-03
2250	850	1.303-02
2300	900	2.201-02
2350	950	3.638-02
2400	1000	5.861-02
2450	1050	9.177-02
2500	1100	1.394-01
HOLD PERIOD		
2500	1200	2.213-01
2500	1300	3.142-01
2500	1400	3.856-01
2500	1500	4.463-01
2500	1600	4.915-01
2500	1700	5.374-01
2500	1800	5.715-01
2500	1900	6.067-01
2500	2000	6.329-01
2500	2100	6.565-01

TABLE C.4. CASE : 1 K/S, PEAK TEMP. 2700 K

TEMPERATURE	TRANSIENT TIME	IODINE RELEASE
RAMP PERIOD		
1400	0	4.909-06
1450	50	9.249-05
1500	100	9.351-05
1550	150	9.447-05
1600	200	9.673-05
1650	250	1.108-04
1700	300	1.125-04
1750	350	1.345-04
1800	400	1.755-04
1850	450	2.425-04
1900	500	3.599-04
1950	550	5.663-04
2000	600	9.233-04
2050	650	1.538-03
2100	700	2.599-03
2150	750	4.438-03
2200	800	7.617-03
2250	850	1.303-02
2300	900	2.201-02
2350	950	3.638-02
2400	1000	5.861-02
2450	1050	9.177-02
2500	1100	1.394-01
2550	1150	2.048-01
2600	1200	2.899-01
2650	1250	3.965-01
2700	1300	5.007-01
HOLD PERIOD		
2700	1400	6.244-01
2700	1500	7.052-01
2700	1600	7.613-01
2700	1700	8.019-01
2700	1800	8.326-01
2700	1900	8.563-01
2700	2000	8.751-01
2700	2100	8.903-01
2700	2200	9.027-01
2700	2300	9.130-01

TABLE C.5. CASE : 1 K/S, PEAK TEMP. 3000 K

TEMPERATURE RAMP PERIOD	TRANSIENT TIME	IODINE RELEASE
1400	0	4.909-06
1450	50	9.249-05
1500	100	9.351-05
1550	150	9.447-05
1600	200	9.673-05
1650	250	1.108-04
1700	300	1.125-04
1750	350	1.345-04
1800	400	1.755-04
1850	450	2.425-04
1900	500	3.599-04
1950	550	5.663-04
2000	600	9.233-04
2050	650	1.538-03
2100	700	2.599-03
2150	750	4.438-03
2200	800	7.617-03
2250	850	1.303-02
2300	900	2.201-02
2350	950	3.638-02
2400	1000	5.861-02
2450	1050	9.177-02
2500	1100	1.394-01
2550	1150	2.048-01
2600	1200	2.899-01
2650	1250	3.965-01
2700	1300	5.007-01
2750	1350	5.969-01
2800	1400	6.869-01
2850	1450	7.649-01
2900	1500	8.299-01
2950	1550	8.819-01
3000	1600	9.210-01

HOLD PERIOD

3000	1700	9.516-01
3000	1800	9.671-01
3000	1900	9.761-01
3000	2000	9.818-01
3000	2100	9.857-01
3000	2200	9.884-01
3000	2300	9.905-01
3000	2400	9.919-01
3000	2500	9.932-01
3000	2600	9.941-01

TABLE C.6. CASE : 5 K/S, PEAK TEMP. 2000 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
HOLD PERIOD		
2000	220	2.846-03
2000	320	3.694-03
2000	420	4.538-03
2000	520	5.379-03
2000	620	6.217-03
2000	720	7.050-03
2000	820	7.881-03
2000	920	8.708-03
2000	1020	9.531-03
2000	1120	1.035-02

TABLE C.7. CASE : 5 K/S, PEAK TEMP. 2100 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
HOLD PERIOD		
2100	240	4.544-03
2100	340	6.714-03
2100	440	8.862-03
2100	540	1.099-02
2100	640	1.309-02
2100	740	1.517-02
2100	840	1.722-02
2100	940	1.926-02
2100	1040	2.126-02
2100	1140	2.325-02

TABLE C.8. CASE : 5 K/S, PEAK TEMP. 2200 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
HOLD PERIOD		
2200	260	8.434-03
2200	360	1.363-02
2200	460	1.869-02
2200	560	2.362-02
2200	660	3.035-02
2200	760	3.784-02
2200	860	4.582-02
2200	960	5.420-02
2200	1060	6.289-02
2200	1160	7.182-02

TABLE C.9. CASE : 5 K/S, PEAK TEMP. 2300 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
2250	170	3.884-03
2300	180	5.092-03
HOLD PERIOD		
2300	280	1.769-02
2300	380	3.046-02
2300	480	4.846-02
2300	580	6.832-02
2300	680	8.913-02
2300	780	1.102-01
2300	880	1.312-01
2300	980	1.517-01
2300	1080	1.717-01
2300	1180	1.911-01

TABLE C.10. CASE : 5 K/S, PEAK TEMP. 2400 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
2250	170	3.884-03
2300	180	5.092-03
2350	190	7.029-03
2400	200	1.013-02
HOLD PERIOD		
2400	300	4.032-02
2400	400	8.311-02
2400	500	1.279-01
2400	600	1.710-01
2400	700	2.238-01
2400	800	2.747-01
2400	900	3.227-01
2400	1000	3.522-01
2400	1100	3.795-01
2400	1200	4.193-01

TABLE C.11. CASE : 5 K/S, PEAK TEMP. 2500 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
2250	170	3.884-03
2300	180	5.092-03
2350	190	7.029-03
2400	200	1.013-02
2450	210	1.503-02
2500	220	2.269-02
HOLD PERIOD		
2500	320	1.017-01
2500	420	1.979-01
2500	520	2.951-01
2500	620	3.681-01
2500	720	4.311-01
2500	820	4.757-01
2500	920	5.241-01
2500	1020	5.578-01
2500	1120	5.874-01
2500	1220	6.221-01

TABLE C.12. CASE : 5 K/S, PEAK TEMP. 2700 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
2250	170	3.884-03
2300	180	5.092-03
2350	190	7.029-03
2400	200	1.013-02
2450	210	1.503-02
2500	220	2.269-02
2550	230	3.501-02
2600	240	5.661-02
2650	250	9.779-02
2700	260	1.733-01
HOLD PERIOD		
2700	360	4.099-01
2700	460	5.584-01
2700	560	6.567-01
2700	660	7.309-01
2700	760	7.869-01
2700	860	8.215-01
2700	960	8.478-01
2700	1060	8.685-01
2700	1160	8.849-01
2700	1260	8.983-01

TABLE C.13. CASE : 5 K/S, PEAK TEMP. 3000 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	10	2.447-05
1500	20	6.971-05
1550	30	1.014-04
1600	40	1.379-04
1650	50	2.099-04
1700	60	3.896-04
1750	70	7.243-04
1800	80	1.304-03
1850	90	1.734-03
1900	100	1.899-03
1950	110	1.982-03
2000	120	2.063-03
2050	130	2.180-03
2100	140	2.364-03
2150	150	2.658-03
2200	160	3.130-03
2250	170	3.884-03
2300	180	5.092-03
2350	190	7.029-03
2400	200	1.013-02
2450	210	1.503-02
2500	220	2.269-02
2550	230	3.501-02
2600	240	5.661-02
2650	250	9.779-02
2700	260	1.733-01
2750	270	2.922-01
2800	280	4.379-01
2850	290	5.651-01
2900	300	6.821-01
2950	310	7.779-01
3000	320	8.499-01

HOLD PERIOD		
3000	420	9.397-01
3000	520	9.664-01
3000	620	9.782-01
3000	720	9.845-01
3000	820	9.883-01
3000	920	9.909-01
3000	1020	9.926-01
3000	1120	9.939-01
3000	1220	9.948-01
3000	1320	9.956-01

TABLE C.14. CASE : 10 K/S, PEAK TEMP. 2300 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	
1450	5	4.909-06
1500	10	8.267-06
1550	15	2.586-05
1600	20	5.305-05
1650	25	8.497-05
1700	30	1.337-04
1750	35	2.395-04
1800	40	4.967-04
1850	45	9.224-04
1900	50	1.542-03
1950	55	2.048-03
2000	60	2.331-03
2050	65	2.504-03
2100	70	2.636-03
2150	75	2.774-03
2200	80	2.959-03
2250	85	3.238-03
2300	90	3.664-03
		4.317-03
HOLD PERIOD		
2300	190	
2300	290	1.585-02
2300	390	2.819-02
2300	490	4.556-02
2300	590	6.502-02
2300	690	8.561-02
2300	790	1.066-01
2300	890	1.275-01
2300	990	1.480-01
2300	1090	1.681-01
		1.875-01

TABLE C.15. CASE : 10 K/S, PEAK TEMP. 2500 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	5	8.267-06
1500	10	2.586-05
1550	15	5.305-05
1600	20	8.497-05
1650	25	1.337-04
1700	30	2.395-04
1750	35	4.967-04
1800	40	9.224-04
1850	45	1.542-03
1900	50	2.048-03
1950	55	2.331-03
2000	60	2.504-03
2050	65	2.636-03
2100	70	2.774-03
2150	75	2.959-03
2200	80	3.238-03
2250	85	3.664-03
2300	90	4.317-03
2350	95	5.323-03
2400	100	6.876-03
2450	105	9.447-03
2500	110	1.443-02
HOLD PERIOD		
2500	210	8.831-02
2500	310	1.873-01
2500	410	2.737-01
2500	510	3.495-01
2500	610	4.153-01
2500	710	4.724-01
2500	810	5.111-01
2500	910	5.558-01
2500	1010	5.854-01
2500	1110	6.115-01

TABLE C.16. CASE : 10 K/S, PEAK TEMP. 2700 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	5	8.267-06
1500	10	2.586-05
1550	15	5.305-05
1600	20	8.497-05
1650	25	1.337-04
1700	30	2.395-04
1750	35	4.967-04
1800	40	9.224-04
1850	45	1.542-03
1900	50	2.048-03
1950	55	2.331-03
2000	60	2.504-03
2050	65	2.636-03
2100	70	2.774-03
2150	75	2.959-03
2200	80	3.238-03
2250	85	3.664-03
2300	90	4.317-03
2350	95	5.323-03
2400	100	6.876-03
2450	105	9.447-03
2500	110	1.443-02
2550	115	2.595-02
2600	120	5.417-02
2650	125	1.153-01
2700	130	2.109-01
HOLD PERIOD		
2700	230	4.517-01
2700	330	5.858-01
2700	430	6.735-01
2700	530	7.445-01
2700	630	8.019-01
2700	730	8.387-01
2700	830	8.631-01
2700	930	8.819-01
2700	1030	8.970-01
2700	1130	9.092-01

TABLE C.17. CASE : 10 K/S, PEAK TEMP. 3000 K

TEMPERATURE (K)	TRANSIENT TIME (S)	IODINE RELEASE FRACTION
RAMP PERIOD		
1400	0	4.909-06
1450	5	8.267-06
1500	10	2.586-05
1550	15	5.305-05
1600	20	8.497-05
1650	25	1.337-04
1700	30	2.395-04
1750	35	4.967-04
1800	40	9.224-04
1850	45	1.542-03
1900	50	2.048-03
1950	55	2.331-03
2000	60	2.504-03
2050	65	2.636-03
2100	70	2.774-03
2150	75	2.959-03
2200	80	3.238-03
2250	85	3.664-03
2300	90	4.317-03
2350	95	5.323-03
2400	100	6.876-03
2450	105	9.447-03
2500	110	1.443-02
2550	115	2.595-02
2600	120	5.417-02
2650	125	1.153-01
2700	130	2.109-01
2750	135	3.383-01
2800	140	4.873-01
2850	145	6.288-01
2900	150	7.366-01
2950	155	8.244-01
3000	160	8.898-01

HOLD PERIOD

3000	260	9.609-01
3000	360	9.791-01
3000	460	9.867-01
3000	560	9.906-01
3000	660	9.930-01
3000	760	9.945-01
3000	860	9.956-01
3000	960	9.964-01
3000	1060	9.969-01
3000	1160	9.974-01

APPENDIX D. DIRECTORY OF FILES

The files used in this work are listed below.

Working Files:

FILENAME	DESCRIPTION
SWBB110	7.5 MW CHANNEL INPUT DATA (FROM O.H.)
SWBB120	6.7 MW CHANNEL INPUT DATA (FROM O.H.)
SWBB130	6.2 MW CHANNEL INPUT DATA (FROM O.H.)
SWBB140	5.7 MW CHANNEL INPUT DATA (FROM O.H.)
SWBB150	4.6 MW CHANNEL INPUT DATA (FROM O.H.)
VJL1	7.5 MW CHANNEL, HIGH TEMPERATURE CASE
VJL2	6.7 MW CHANNEL, HIGH TEMPERATURE CASE
VJL3	6.2 MW CHANNEL, HIGH TEMPERATURE CASE
VJL4	5.7 MW CHANNEL, HIGH TEMPERATURE CASE
VJL5	4.6 MW CHANNEL, HIGH TEMPERATURE CASE
KRW1	7.5 MW CHANNEL, REFERENCE TEMP. CASE
KRW2	6.7 MW CHANNEL, REFERENCE TEMP. CASE
KRW3	6.2 MW CHANNEL, REFERENCE TEMP. CASE
KRW4	5.7 MW CHANNEL, REFERENCE TEMP. CASE
KRW5	4.6 MW CHANNEL, REFERENCE TEMP. CASE

FILENAME	DESCRIPTION
RUNCU01	CURIES-II, 1 K/S RAMP RATE
RUNCU05	CURIES-II, 5 K/S RAMP RATE
RUNCU10	CURIES-II, 10 K/S RAMP RATE
FAST01	FASTGRASS, 1 K/S RAMP RATE
FAST05	FASTGRASS, 1 K/S RAMP RATE
FAST10	FASTGRASS, 1 K/S RAMP RATE
CUREST	REST, CURIES-II VERSION
FSTREST	REST, FASTGRASS VERSION
CREST1	REST DATA, 7.5 MW CHANNEL, REF. TEMP.
CREST2	REST DATA, 6.7 MW CHANNEL, REF. TEMP.
CREST3	REST DATA, 6.2 MW CHANNEL, REF. TEMP.
CREST4	REST DATA, 5.7 MW CHANNEL, REF. TEMP.
CREST5	REST DATA, 4.6 MW CHANNEL, REF. TEMP.
HTREST1	REST DATA, 7.5 MW CHANNEL, HIGH TEMP.
HTREST2	REST DATA, 6.7 MW CHANNEL, HIGH TEMP.
HTREST3	REST DATA, 6.2 MW CHANNEL, HIGH TEMP.
HTREST4	REST DATA, 5.7 MW CHANNEL, HIGH TEMP.
HTREST5	REST DATA, 4.6 MW CHANNEL, HIGH TEMP.

Archive Files:

FILENAME	DESCRIPTION
CHANRUN	CONTAINS VJL1 -.VJL5
CURRUN	CONTAINS RUNCU01, RUNCU05, RUNCU10
KRCHAN	CONTAINS KRW1 - KRW5
FSTRUN	CONTAINS FAST01, FAST05, FAST10
RUNREST	CONTAINS CREST1-CREST5, HTREST1-HTREST5